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ABSTRACT

The technology-based student activities in this curriculum resource book are intended to be incorporated into any industrial arts/technology education program. The activities are classified according to one of four technological systems--construction, communications, manufacturing, and transportation. Within the four parts of the guide, individual activities are presented in their own sections. Each of these sections includes the following: activity title, contributor, time required, activity description, key vocabulary terms used in the activity, objectives, a listing of special supplies and equipment needed, transparency masters and student handouts, definitions of related key terms, pertinent applied mathematics and science principles, the social and/or environmental impact of the topic under study, creative problem-solving activities, related careers, and references. Various hands-on activities are described, including simulating a newsroom, making a basic siren/code oscillator, using a computer to design (and eventually producing) a heat-sensitive T-shirt transfer, constructing and testing different types of airfoils and a model rocket, developing a propeller-driven car, constructing an air-cushion vehicle, constructing models of various types of bridges, building a model structure or superstructure to solve a design problem, constructing a solar water heater, and using fundamental research and development principles to design and construct a model racing car. (MN)

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CE

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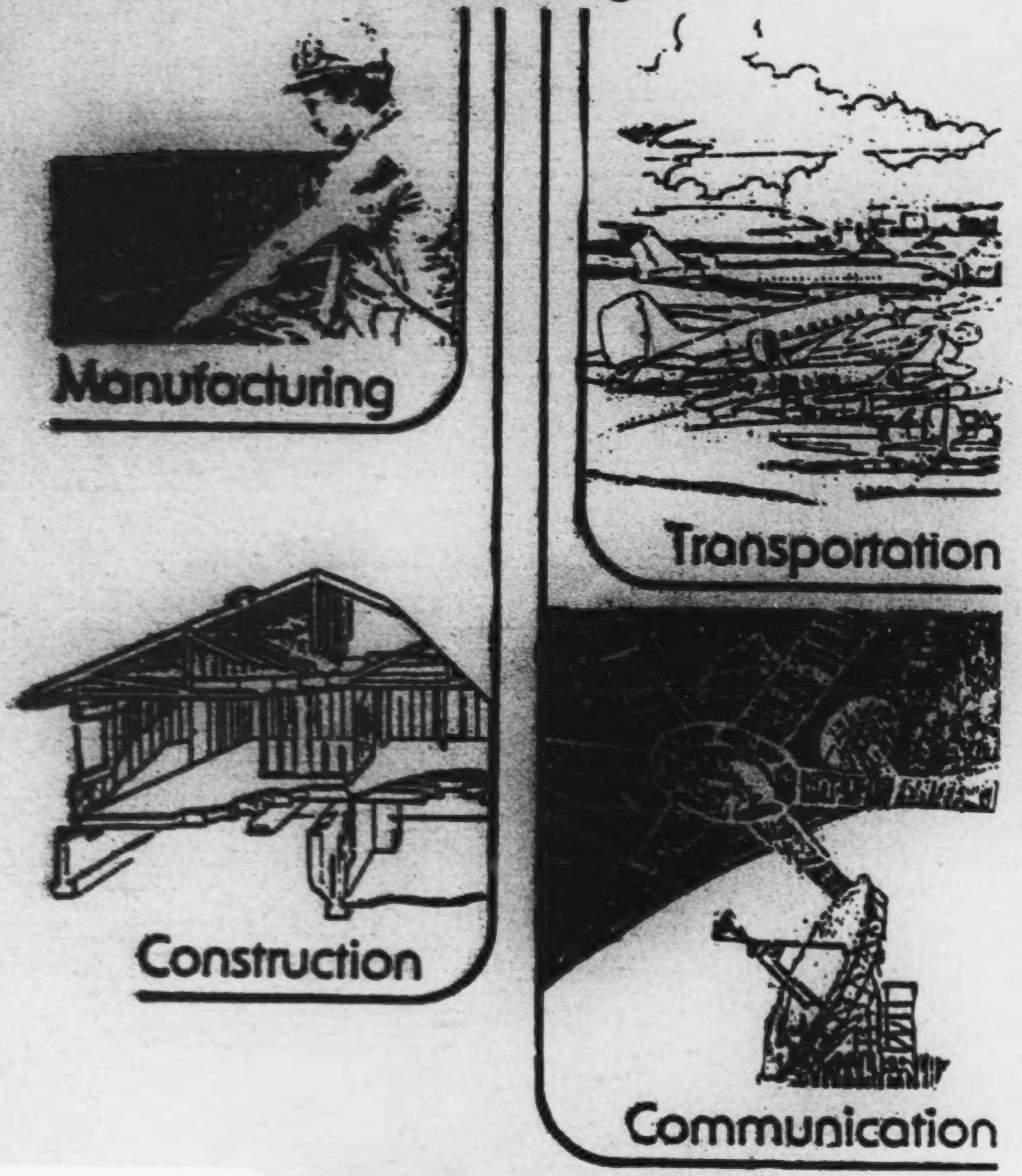
Technology



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INDUSTRIAL ARTS/TECHNOLOGY EDUCATION
DIVISION OF VOCATIONAL EDUCATION
STATE DEPARTMENT OF PUBLIC INSTRUCTION
1987

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Activities and procedures within the Division of Vocational Education are governed by the philosophy of simple fairness to all. Therefore, the policy of the Division is that all operations will be performed without regard to race, sex, color, national origin, or handicap.

INTRODUCTION

The technology-based student activities in this curriculum resource book are designed to be incorporated in any industrial arts/technology education program. The activities are classified in one of four technological systems--Construction, Communications, Manufacturing, Transportation.

Though the activities are classified within one of the four technological systems, many are transferable into multiple systems. Further, the activities are appropriate for use at different grade levels. The flexibility is in the hands of the instructor who uses them and in the instructor's ability to modify the activities to meet multiple objectives.

All technology-based student activities included in the resource book were developed by the following Michigan classroom teachers:

Ed Ball	Forsythe Intermediate School, Ann Arbor
Chuck Gosdzinski	Johannesburg-Lewiston High School, Johannesburg
Chuck Meddaugh	Mason High School, Mason
Jim Partridge	Summerfield High School, Petersburg
Lee Schaude	Kinawa Middle School, Okemos

Appreciation is expressed to these educators and to Jim Rudnick, Michigan State Department of Education, for sharing the resource book for use in North Carolina schools.

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COMMUNICATION

Activities for Teaching Technology

Activity Title	PACKAGING
Contributor	LEE E. SCHAUDE
Time Required	1 WEEK (5 DAYS)
Activity Description	In this activity the students will design and fabricate a package to hold, protect, and advertise its contents.

Terms

ART/ADVERTISEMENT
CATCHWORDS
COMMUNICATIONS
IMAGE
PACKAGE
PATTERN DEVELOPMENT
PROTOTYPE

SOAP
SOAP
SOAP
SOAP

Objectives

The student should be able to:

Analyze various packaging techniques.

Identify fraudulent or deceptive packaging.

Graphically illustrate a package to describe its contents.

Use pattern development techniques to design a package for a specified product.

Become aware of techniques industry uses to draw people to their products.

Special Supplies & Equipment	Supplier
Paper and/or poster board	
Rubber Cement	
Felt tip markers	
Transfer type	
Assorted drafting equipment	

Transparency Masters
&
Student Handouts

PACKAGING ACTIVITIES

1. Have your students bring a package to class that they think is the most outstanding package they can find.

   A. Analyze the packages on the following:

      1.) Color
      2.) Shape
      3.) Texture
      4.) Catchwords

2. Give each student a standard package or container (box or pop can) and have them decorate this to please a potential buyer. Survey other students to find out why they would purchase the product the package would contain.

3. Have students research packages that they feel are deceptive. If the students discover a fradulant packaging procedure (false weights, misrepresenting the contents, and etc.) they can write to The Federal Trade Commission, 633 Indiana Avenue N.W., Washington, DC 20580

4. Complete 'Packaging Assignment'.

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ELEMENTS OF A PACKAGE

1. A STRUCTURE THAT HOLDS THE CONTENTS.
2. LOGO
3. COMPANY INFORMATION
    - A. NAME
    - B. ADDRESS
4. VERBAL DESCRIPTION OF CONTENTS
    - A. NAME
    - B. WEIGHT, VOLUME, OR QUANTITY
    - C. COLOR
5. DIRECTIONS AND/OR CAUTIONS

STUDENT OBJECTIVE: The student should be able to use layout techniques and message analysis to create a suitable package design.

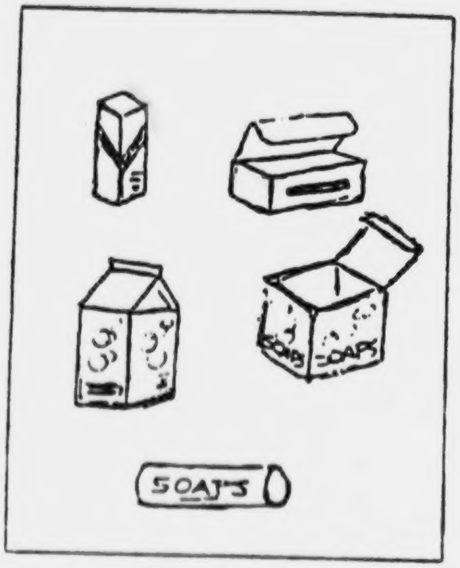
ACTIVITY DESCRIPTION

1. Design a package for a product. The package can be an improvement of an existing one or an entirely new one.
2. Prepare at least five thumbnail sketches to decide which is best for your package.
3. Prepare a rough layout from your best thumbnail.
4. Using good layout techniques, prepare a comprehensive layout of your package. This should include all typestyles, colors and paper choices you feel will look best on your package. This is a hand-rendered layout with a cover sheet to indicate specifications.
5. Prepare a prototype of your package. Use type, colors, and paper as indicated on your comprehensive.

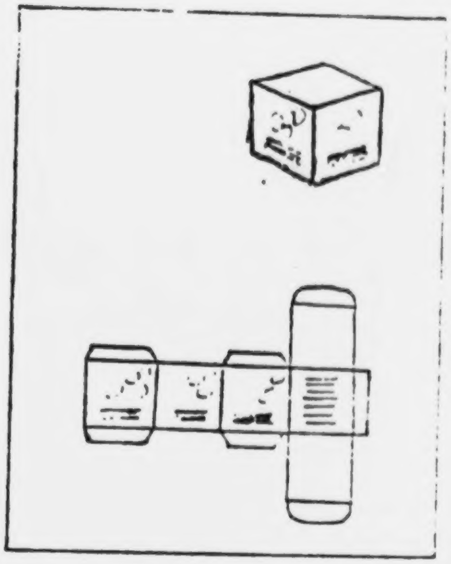
HELPFUL HINTS

1. Identify your consumer.
2. Choose colors and typestyles that will appeal to your consumer.
3. Browse through the aisles of a grocery store to gather ideas...look through cabinets...look in catalogs... brainstorm ideas.
4. Above all, BE CREATIVE!!!

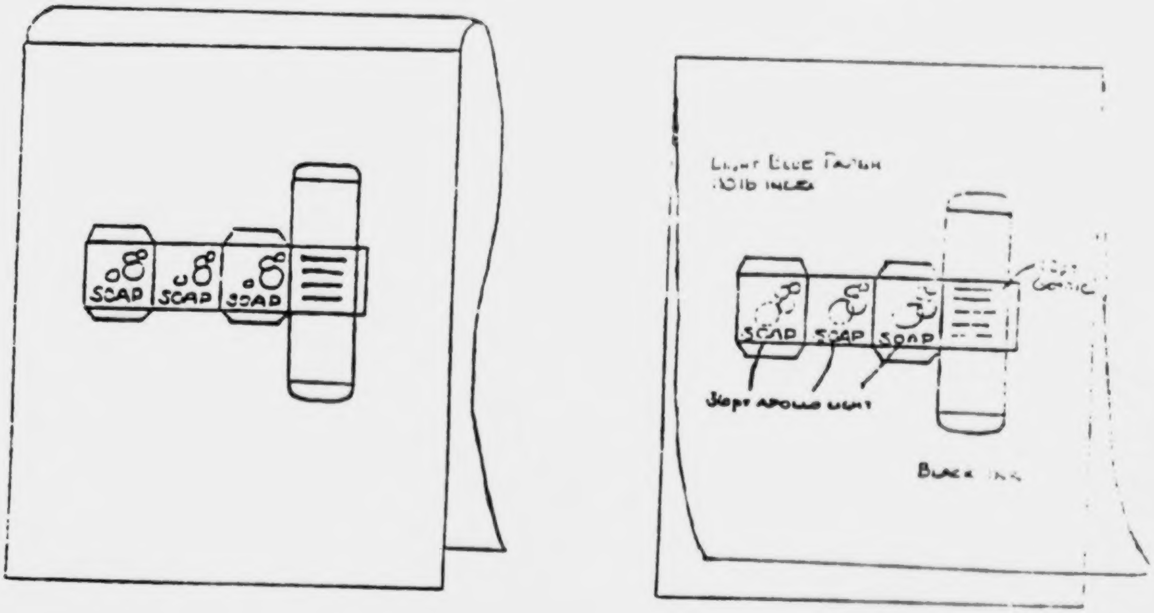
SAMPLE


SOAPS
SOAPS
SOAP'S

THUMBNAIL



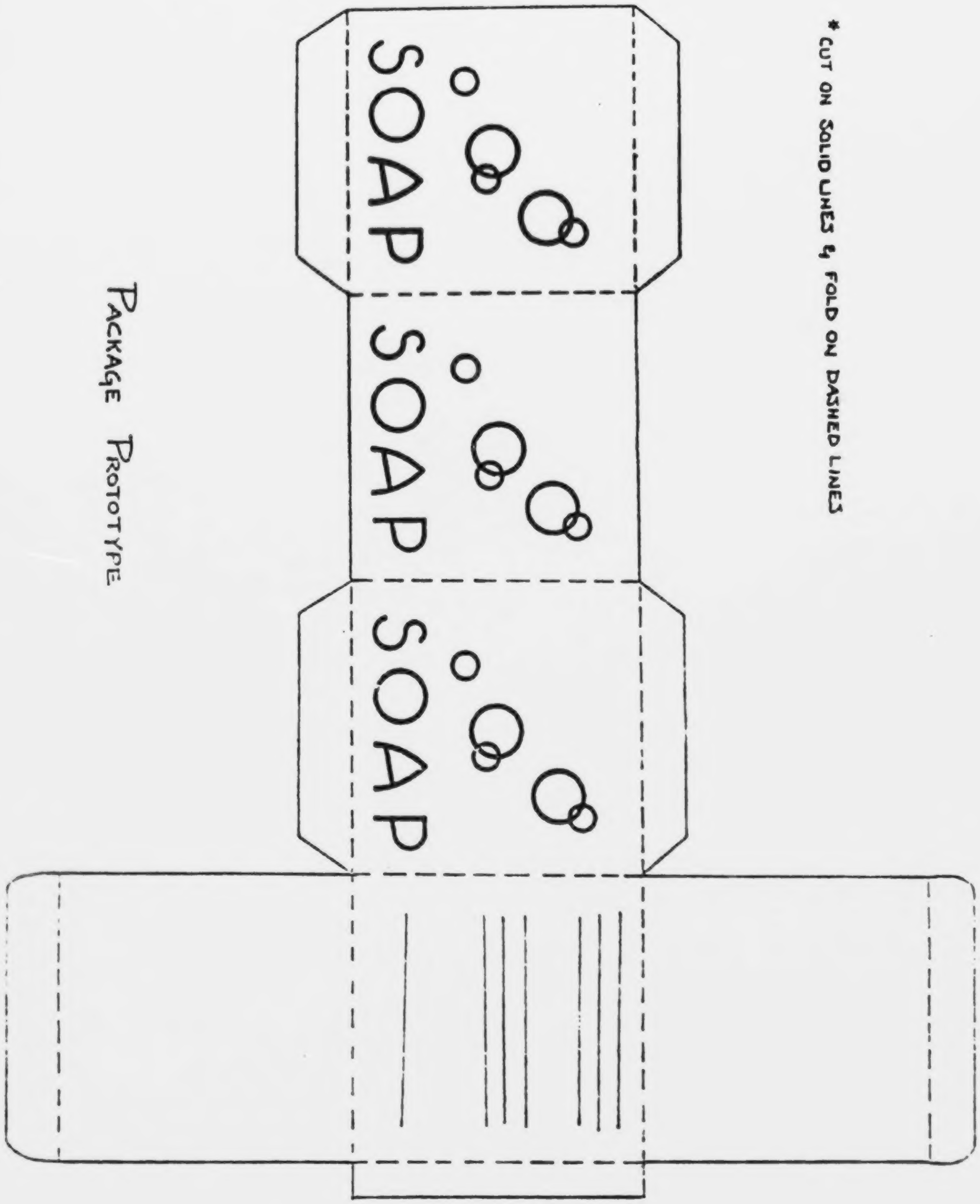
ROUGH


SOAP
SOAP
SOAP
LIGHT BLUE PAPER
.016 INCH
SOAP
SOAP
SOAP
GOTHIC
36PT APOLLO LIGHT
BLACK INK

COMPREHENSIVE

SAMPLE

*CUT ON SOLID LINES & FOLD ON DASHED LINES


SOAP
SOAP
SOAP

PACKAGE PROTOTYPE

Definition of Terms

ART/ADVERTISEMENT:	A notice or graphic designed to attract public attention.
CATCHWORDS:	A word or phrase that attracts the attention, i.e. super or new.
COMMUNICATIONS:	The means by which messages, thoughts, and/or ideas are transmitted.
IMAGE:	The graphic message to grasp and hold attention.
PACKAGE:	A container to hold, protect, and advertise a product.
PATTERN DEVELOPMENT:	The design of a 3 dimensional object that is made from a flat material like paper, cardboard, or sheetmetal.
PROTOTYPE:	An original form or model.

Applied Math & Science Principles

Measurement (linear and volume)

Social / Environmental Impact

Appearances affect how we respond to things:

- people
- products
- foods
- etc.

Deception - people are often fooled about a product by the package.

Americans pay over $25 billion extra for packaging of contents -- 90% of these are discarded.

i.e. 26 billion glass bottles
5 billion cans

Creative Problem Solving Activities

1. Design and construct a package that will protect an egg or light bulb when dropped on a concrete floor. Hold a contest to see whose package will protect the contents for the greatest distance dropped.
2. Design and construct a package that will show the contents of the package to the potential buyer.
3. With today's growing concern over our environment some companies now package and sell 'pure' water. Have your students design a package to sell 'clear fresh air'.
4. Design a record album cover that describes the music of a hit record.
5. Design a package to hold a professional football linebacker.
6. Prepare a script and produce a 30 second video commercial to advertise one of the above.
7. How can we reuse old packages?

Related Careers

Advertising

Artist/Commercial

Graphic Arts

Draftsperson

Packaging

Printer

References

Baker, Carole; Teacher for Detroit Public Schools

Weston, Robert; "Packaging", Learning, 1974.

Adams, J. and Faux, D. Printing Technology: A Medium of Visual Communications; North Scituate, MA; Duxbury 1979.

Walker, J.; Graphic Arts Fundamentals. South Holland, ICC: Goodheart-Wilcox; 1980.

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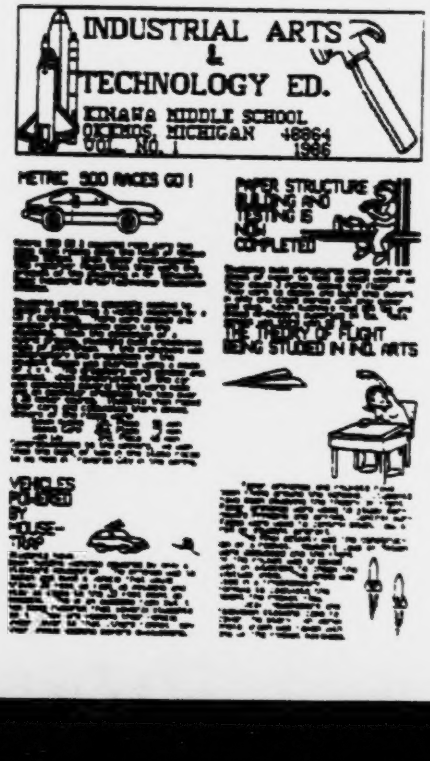
Activities for Teaching Technology

Activity Title	NEWSROOM
Contributor	LEE SCHAUDE
Time Required	VARIABLE - ON-GOING
Activity Description	Students will gather information and, using a computer, produce an Industrial Arts/Technology Education newsletter.

Terms

- BANNER
- BOOTING
- CAPTION
- CLIP ART
- COLUMN
- COPY DESK
- DATA DISK
- FONT
- HEADLINE
- LAYOUT
- PANEL
- PHOTO LAB
- PRINTING PRESS
- TEXT
- WIRE SERVICE



INDUSTRIAL ARTS
&
TECHNOLOGY ED.
KINAWA MIDDLE SCHOOL
OKEMOS, MICHIGAN 48864
VOL. NO. 1 1986

METRIC 500 RACES GO!

PAPER STRUCTURE BUILDING AND TESTING IS NOW COMPLETED

THE THEORY OF FLIGHT BEING STUDIED IN IND. ARTS

VEHICLES POWERED BY MOUSE-TRAP

Objectives

Students will:

Design and produce a newspaper.

Develop a sense of pride towards their accomplishments in the IA/TE classroom.

Develop confidence and skill in using a computer.

Develop an understanding of the newspaper industries.

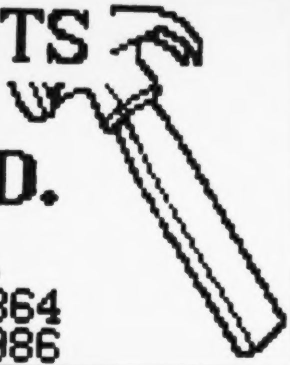
Function as part of a team with a common goal.

Special Supplies & Equipment	Supplier
Newsroom Software	COM4
Computer (Apple IIe)	
Printer	
Computer Paper	

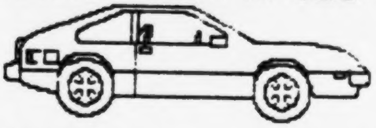
Transparency Masters
&
Student Handouts

INDUSTRIAL ARTS & TECHNOLOGY ED.

KINAWA MIDDLE SCHOOL
OKEMOS, MICHIGAN 48864
VOL. NO. 1 1986



METRIC 500 RACES GO !



Metric 500 CO 2 powered race cars hve been seen racing down the halls of Kinawa Middle School. Upon closer investigation this reporter found that they were the product of the students in Mr. Schaude's Basic Industrial Arts/Technology Education classes.

Students used the scientific method to design and produce a vehicle powered by a CO 2 cartridge. There were minimum and maximum specifications given to the students. Upon the completion of a metric drawing, students build prototypes made of styrofoam. If the prototype was satisfactory the production of the student design was started using a piece of 2 x 4. The dragsters were sanded and painted. When construction of the car was completed several tests were made and an computer predicted the time over a 33 meter course. Students then raced their cars and calculated there speed. Winners of the races were:

Kevin Kuene	1st. Place	86 mph
Scott Carp	2nd. Place	[illegible]3 mph
Jan Liu	3rd. Place	58 mph

Congratulations to the winners. We wish them the best of luck in the State races to be held in Traverse City in the spring.

VEHICLES POWERED BY MOUSE-TRAP

Students have been building vehicles powered by only a standard mousetrap. The problem was to design and build a vehicle that would travel 20 feet as fast as possible and stay as close to the 20 foot point as possible. This is an awesome task but it has been rumored that several students did it. They are keeping their vehicle under cover so that others cannot copy their unique designs before evaluations.

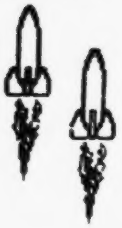
PAPER STRUCTURE BUILDING AND TESTING IS NOW COMPLETED

Students build structures using only one sheet of paper to hold as much weight as they could 3 inches above the floor. They were to design and build this suport in only one class period with only paper and glue. Kevin Kuehne's held 104 lbs and Ahmad Al-Oteiby's suported 94 lbs. Matt Annett was third with 92 lbs.

THE THEORY OF FLIGHT BEING STUDIED IN IND. ARTS

Paper airplanes and rockets have been flying around the schools. Students have been studying the theory of flight. Paper airplanes were used to study Bernoulli's Principle and airfoils. Control surfaces were used to control pitch, yaw, & roll of student aircraft.

The final activity was the construcion of a rocket. Newton's Laws of Motion were discussed and the flight of the rocket was tracked with an altiscope to check the altitude angle. This angle was used in a trigonometry formula to calculate the height the rocket flew.



Local newspapers and television stations came to cover the story. An aerial photo graph was taken with one of the rocket payloads.

THE NEWSROOM

Overview

Function keys:

🍏 (open apple) - selector key

🍎 (closed apple) - selector key

RETURN (return key) - selector key when saving to a disk

← → ↑↓ (arrow keys) - moves the cursor in designated direction

CTRL - S - toggles between large and small step cursor movement

CTRL - A - turns sound on and off

Main menu options:

Banner - allows user to create a banner, logo or flag

Photo lab - allows user to choose and/or create pictures (photos) for inclusion in the newspaper

Copy desk - work area where the text (copy) is written

Layout - allows user to arrange created panel (copy and photos) and banners on a page

Press - allows user to print a photo, banner, panel or page

Wire service - allows user to send or receive papers, panels, banners, or photos via a modem and phone line

Work Areas

NOTE: Put the Master Program disk in drive 1 and the Clip Art disk in drive 2.

I. Banner

  A. Highlight and select BANNER from the Main Menu

    1. Choose a photo from the Clip Art disk

      a. select the clip art icon

b. choose desired work from the list

c. move the cursor (hand) on top of desired photo and select with function key

d. move the photo to desired location on banner

e. drop the photo into place by pressing the selector key

f. remove original or "extra" photo by dragging it off the left side of the workspace

OPTION: To flip the photo, select the flip icon. Move the cursor on top of the photo and press the selector key.

2. Create a photo using the Graphic Tools

a. select the crayon icon

b. choose desired graphic tool by placing the cursor on top of appropriate tool and selecting

c. EXIT to workspace

d. drop the tool by pressing the selector key

e. use arrow keys and selector keys to draw the photo

3. Adding text

a. select the crayon icon

b. choose desired font style by placing the cursor on top of appropriate type and selecting

c. EXIT to workspace

d. place the cursor where text should begin

e. drop the cursor and begin typing

f. when text is complete, press the selector key to move the cursor from workspace

OTHER ICONS:

🔍 - the magnifying glass icon allows user to magnify a portion of the screen

OOPS - the oops icon allows user to undo what was just done

🗑 - garbage can icon clears the work area

MENU - the menu icon returns user to The Newsroom Menu

4. Saving the banner

   a. select the disk icon

   b. select Save banner from the menu

   c. insert a data disk in drive 2

   d. initialize the data disk

   e. type the name of the banner and press RETURN

   f. return to the Main Menu

II. Photo Lab

A. Highlight and select PHOTO LAB from the Main Menu

1. Choose a photo from the Clip Art disk

   a. insert the Clip Art disk in drive 2

   b. select clip art icon

   c. choose desired work from list

   d. move the cursor (hand) on top of desired photo and selector with function key

   e. move the photo to desired position in workspace

   f. drop the photo into place by pressing the selector key

   g. remove original or "extra" photo by dragging it off the left side of the workspace

OPTION: To flip the photo, select the flip icon. Move the cursor on top of the photo and press the selector key.

2. Create a photo using the Graphic Tools

   a. select the crayon icon

   b. choose desired graphic tool by placing the cursor on top of appropriate tool and selecting

   c. EXIT to workspace

   d. drop tool by pressing the selector key

   e. use arrow keys and selector keys to draw the photo

*The remaining icons in the photo lab have the same functions as those in the banner work area.

3. Taking the picture

NOTE: Before a photo can be saved it must be cropped and have its picture taken.

   a. select the camera icon

   b. move the cursor back onto the workspace

   c. drop the cursor where the bottom left corner of the cropping frame should begin

   d. move the cursor across the photo, framing the photo as the cursor moves

   e. when the photo is framed properly, press the selector key and a "picture" will be taken of the photo

   f. move the cursor off the left side of the workspace

4. Saving the photo

   a. select the disk icon

   b. select Save photo from the menu

   c. insert a data disk

   d. type the name of the photo and press RETURN

   e. return to the Main Menu

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III. Copy Desk

A. Highlight and select COPY DESK from the Main Menu

NOTE: Step #1 should be done first if the panel will include a photo

1. Placing the photo in copy area
    - a. insert the data disk on which the photo has been saved
    - b. select the disk icon
    - c. select Load photo from the menu
    - d. choose desired work from the list
    - e. move the empty frame to desired location on panel
    - f. drop the photo in place by pressing the selector key
2. Adding text
    - a. select the font icon
    - b. choose desired font style by placing the cursor on top of appropriate type and selecting
    - c. move the cursor onto the workspace and begin typing

NOTE: *Do not press return at the end of a line of text.

*The eraser icon erases all text from the work area.

*To erase a character:

-use the arrow keys to place the cursor on top of the character to remove and press the DELETE key

*To insert new text within existing text:

-move the cursor to where the new text should appear and type

*If there is no longer any room in the panel for text or photos, save the panel, clear the workspace and continue.

*The remaining icons in the copy desk work area have the same functions as those in the banner work area.

IV. Layout

A. Highlight and select LAYOUT from the Main Menu

1. Arranging the page

   a. select the appropriate layout options from the two menus

2. Lay out the page

   a. insert the data disk on which the panels have been saved

   b. move the cursor to a panel/banner area

   c. press the selector key to view a list of saved panels/banners

   d. use the arrow keys to scroll through the list

   e. highlight and select desired panel/banner (the name of the panel/banner will appear in designated area)

   f. continue assigning panels/banners until the page is complete

3. Saving the page

   a. highlight and select SAVE from the Layout Menu

   b. type the name of the page and press RETURN

   c. return to the Main Menu

V. Press

A. Highlight and select PRESS from the Main Menu

1. Printing the page

   a. select Print page from the menu

   b. insert the data disk on which the page has been saved

   c. select the page to print by scrolling through the titles, highlighting, and selecting

   d. insert paper into printer

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Definition of Terms

BANNER:	Name of a newspaper in large letters across the top of the front page, logo or flag.
BOOTING:	The process of loading computer program into computer by following manufacturer's suggested method.
CAPTION:	A label beneath or above a photo.
CLIP ART:	Artwork available for photos in Newsroom Program.
COLUMN:	Vertical division (2) of text in the makeup of newspaper. or Regularly appearing articles in newspaper that are written by the same person reflecting a particular point of view.
COPY DESK:	The work area where panels are created.
DATA DISK:	Computer disk that is used for storing work completed.
FONT:	A complete set of type in one size and one style.
HEADLINE:	Large type summarizing contents of an article.
LAYOUT:	Work area where panels and banners are arranged into pages.
PANEL:	A section of newsroom page (1/8) that may contain pictures, text, headline; or pictures, text, and headline.
PHOTO LAB:	Work area where photos are chosen, arranged, and/or altered.
PRINTING PRESS:	Work area where pages are printed as arranged in the Layout work area.
TEXT:	Written story.
WIRE SERVICE:	Computer process using a modem where computers can hook together over the telephone.

Applied Math & Science Principles

Layout

Design

Proportion

Balance

Spatial Relationships

Social / Environmental Impact

Influence of media on population

High technology is changing media

- quantity
- speed/distance (instant world wide)
- population reached
- computer/laser/satellite

Creative Problem Solving Activities

1. As a class, organize a newspaper organization and put out a monthly newspaper telling about class activities.

2. Have classes, with representatives from each class, organize a newspaper and publish.

   A. Industrial Arts/Technology Education
   B. School Wide News
   C. Sports
   D. Etc.

3. Create a district newspaper for industrial arts/technology education by organizing your high school, and junior high or middle school.

4. Publish a newspaper with another school using a modem and the Wire Service option in the Newsroom program.

Related Careers

Assignment Editor

City Editor

Columnist

Copy Boy

Editor

Editor in Chief

Proofreader

Publisher

Reporter

Journalist

Photographer

Advertising

References

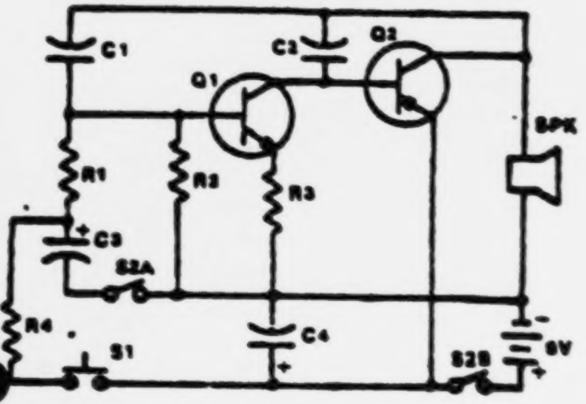
Newsroom; Springboard Software, Inc.; Minneapolis, MN; 1985.

Activities for Teaching Technology

Activity Title	USING ELECTRONICS TO COMMUNICATE
Contributor	ED BALL
Time Required	5 HOURS (1 WEEK)
Activity Description	Electronics play a key role in all areas of technology. The students will develop three electronic skills while participating in this communications activity. The student will explore an area of communications while developing a siren/code oscillator.

Terms

RESISTOR
CAPACITOR
TRANSISTOR
SWITCH
SOLDER
CURRENT
VOLTAGE
RESISTANCE



Objectives

To become acquainted with the communications industry.

To explore the area of electronics as a part of communication technology.

To study electronic developments in communication.

To develop skills in:
- *reading a schematic.
- *wiring a circuit on paper.
- *wiring an actual circuit in the laboratory.

To construct a working electronic circuit.

To understand communicating using electronic devices.

Special Supplies & Equipment

PARTS LIST

Qty.	Symbol	Description	Part No.	Price
1	R1	Resistor, 68K ohms	61419	$.10
1	R2	Resistor, 100K ohms	61374	.10
1	R3	Resistor, 27 ohms	61383	.10
1	R4	Resistor, 22K ohms	61388	.10
1	C1	Capacitor, .01 uF (marked 103)	62364	.10
1	C2	Capacitor, .047 uF (marked 473)	62177	.20
2	C3,4	Capacitor, Elect., 100 uF	61519	.25 ea.
1	Q1	Transistor, NPN, 2SC1815Y	63037	.50
1	Q2	Transistor, PNP, 2SA1015Y	62676	.85
1	S1	Switch, M/C, N/O	62512	1.20
1	S2	Switch, Slide, D.P.D.T. c/o	62540	1.00
1		Speaker	61051	2.00
1		Battery Connector	62403	.25
1		Solder, 12"	63100	.10
1		Instruction Sheet	62540	.50

Supplier

COM5

Transparency Masters
&
Student Handouts

GRAYMARK
INTERNATIONAL, INC.
P.O. Box 17359, Irvine, CA. 92713

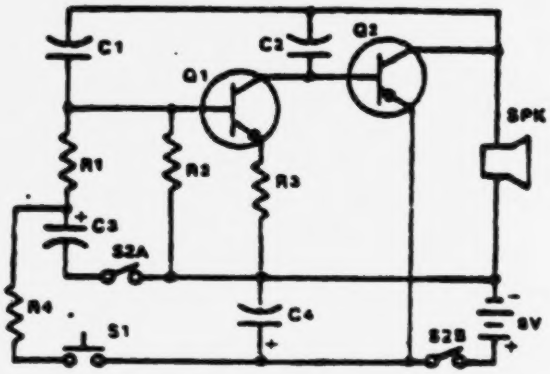
KOMPONENT KITS

SIREN/CODE OSCILLATOR

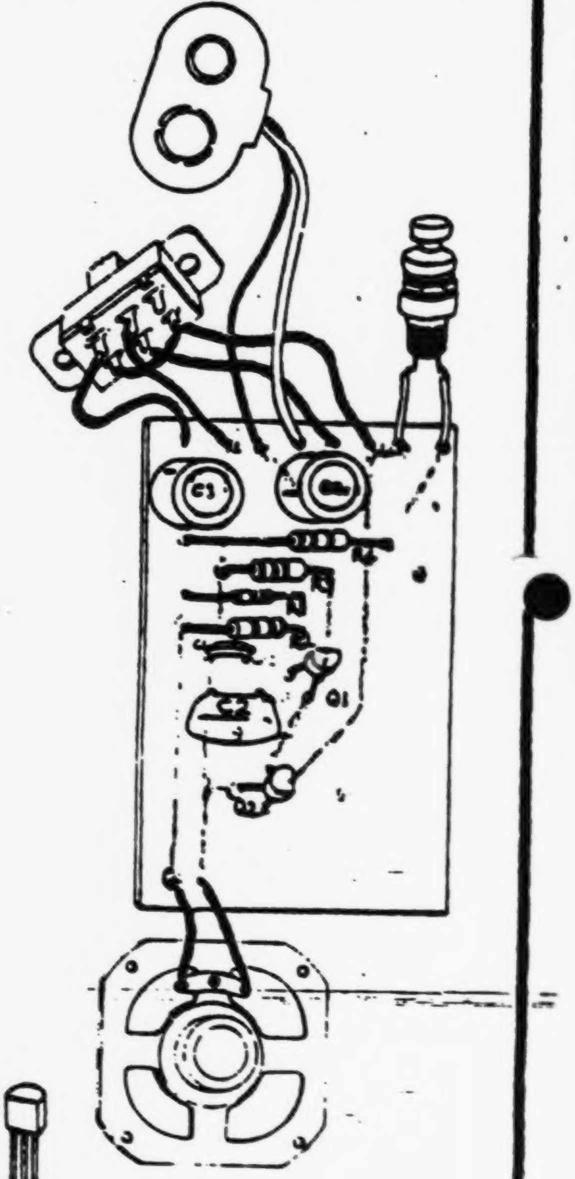
MODEL NO. 120

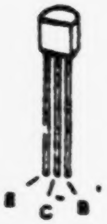
1083/6643

SCHEMATIC



PARTS PLACEMENT PICTORIAL DIAGRAM



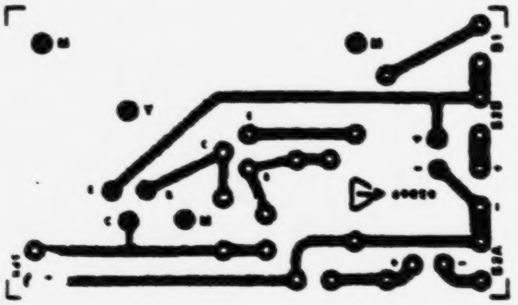


PARTS LIST

Qty.	Symbol	Description	Part No.	Price
1	R1	Resistor, 68K ohms	61419	$.10
1	R2	Resistor, 100K ohms	61374	10
1	R3	Resistor, 27 ohms	61383	.10
1	R4	Resistor, 22K ohms	61388	.10
1	C1	Capacitor, .01 uF (marked 103)	62364	.10
1	C2	Capacitor, .047 uF (marked 473)	62177	.20
2	C3,4	Capacitor, Elect., 100 uF	61519	.25 ea.
1	Q1	Transistor, NPN, 2SC1815Y	63097	.50
1	Q2	Transistor, PNP, 2SA1015Y	62676	.85
1	S1	Switch, M/C, N/O	62512	1.20
1	S2	Switch, Slide, D.P.D.T. c/o	62640	1.00
1		Speaker	61051	2.00
1		Battery Connector	62403	.25
1		Solder, 12"	63169	10
1		Instruction Sheet	62540	.50

17 35

PRINTED CIRCUIT ARTWORK



Definition of Terms

CAPACITOR: a component used in electronic circuits to store electrical energy.

CURRENT: (I) the flow of electrons measured in ampheres (AMP or A).

1 AMP = the flow of 6.25×10^{18} electrons past a given point in one second

NOTE: Current flow is relatively slow, however, the disturbance travels at the speed of light.

RESISTANCE: (R) opposition to the flow of an electric current when a voltage is applied. Measured in OHMS. (Ω)

RESISTOR: component used to introduce resistance into a circuit.
Two types a) fixed resistor
b) variable or adjustable resistor

SOLDER: alloy used to bond metals together. (Usually 60% lead and 40% tin.)

SWITCH: device for making and breaking connections, and thereby closing and opening circuits.

TRANSISTOR: solid-state device for amplifying, controlling, or generating electrical signals.

VOLTAGE: (E) electron pressure or density in an electric wire or circuit caused from an excess of electrons at one end of the conductor and a deficiency of electrons at the other end. Also known as potential difference or electromotive force (EMF). Measured in VOLTS (V).

Applied Math & Science Principles

Ohms Law

Watts Law

Theory of Sound

Social / Environmental Impact

Examine the application of electronics to sound in this circuit. Then discuss the evolution of sound and electronics in the past, present and future.

1. What are the social impacts of having or not having this capability?
2. What are the economical impacts of having or not having this capability?

Creative Problem Solving Activities

1. Research frequency levels and how they pertain to pitch.
2. Research human hearing ranges and where this siren fits.
3. Change the devices or circuits around to study other applications of electronic devices.
4. Besides emergency vehicles, discuss where siren applications may also be better utilized.
5. Build a cabinet or holding device to house your siren!

Related Careers

BROAD AREAS

Electrical Engineering

Electric Light and Power Industry

Construction Electricians

Maintenance Electricians

Manufacturing Occupations

Telephone Industry

Data Communications

Television and Radio Repair

Broadcasting

Satellite Communications

SPECIFIC AREAS

Technicians

Sound Engineers

Lighting Specialists

Camera Operators

References

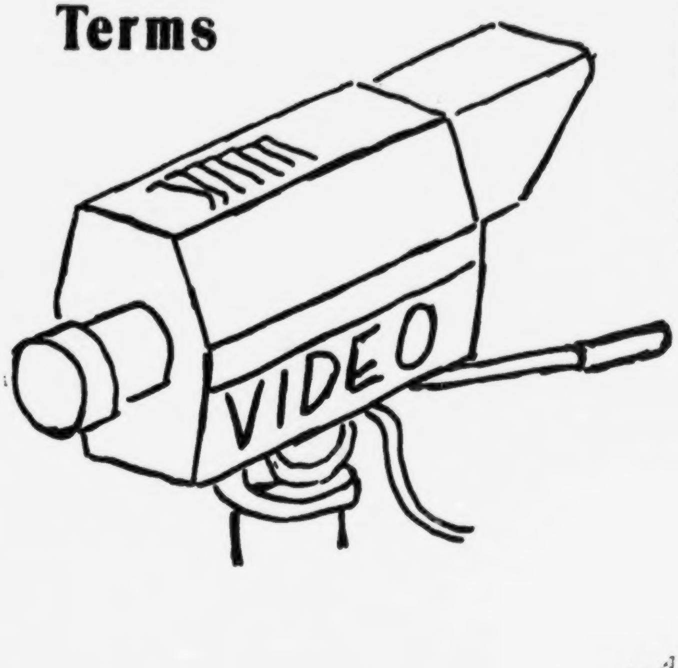
Graymark International Inc., "Komponent Kits", Siren/Code Oscillator, Model No 120. P.O. Box 17359, Irvine, California 92713

Activities for Teaching Technology

Activity Title	VIDEO TECHNOLOGY/PRODUCTION
Contributor	JAMES W. PARTRIDGE
Time Required	10 HRS. (2 WEEKS)
Activity Description	In this activity the students will use a designed package container as the product for a 2 min. commercial using video equipment.

Terms

CAMERA OPERATOR
DIRECTOR
DOLLY
PAN
STAR
STORYBOARDING
TECHNICAL ASSISTANT
TECHNICIAN
TILT



Objectives

The student will:

1. Show an understanding of the technical operations of the taping system.
2. Utilize proper broadcasting techniques and technical processes used to convey a message via a television medium.
3. In groups of 1-4 people, write and produce a 2 min. video commercial.
4. Learn script writing.

Special Supplies & Equipment	Supplier
Video camera	
TV monitor	
Video recording machine	
Microphone	
Blank video tapes (4-5)	

Transparency Masters
&
Student Handouts

INSTRUCTOR HANDOUT

Topics for audio video production unit

1) Talk Show
2) Weather Report
3) Soap Opera
4) Commercial
5) Rock Video
6) Lip Sync
7) Game Show
8) Cooking
9) Movie Review
10) Dance
11) Bloopers
12) Dear Abby
13) Pet Show
14) Selling a Product
15) Consumer Report
16) Gardening
17) Kid Show
18) Comedy Show
19) Fashion Show
20) Magic Act
21) Fishing Report
22) Make-Over
23) Exercise
24) Demonstration
25) All-Star Wrestling
26) People's Court
27) Dating Game

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INSTRUCTOR HANDOUT

TECHNOLOGY EDUCATION DEPARTMENT STUDENT EVALUATION GUIDE

Class__________

Period__________

	Projects																			
Points Possible																				
Student Name																				

STUDENT ACTIVITY:

MAKING A COMMERCIAL

OBJECTIVE:

Using necessary equipment and supplies, design and construct a package for a new product that will be used as one prop in the production of a two minute commercial.

MATERIALS AND SUPPLIES:

Select drafting equipment
Heavy paper or cardboard
Crayons, colored pencils, poster paint, etc.
Glue/tape
Video equipment (TV monitor, microphone, video camera, blank discs)
Selected background materials, old curtains, blankets or wallpaper
 taped to existing walls, or newsprint from butt rolls from local newspaper
Scissors

PRODUCTION SEQUENCE:

1. Create a new product to package.

2. Using radial line development or parallel line development draw, color and cut out and assemble the package prop.

3. Develop the story board:
   a) Determine the initial title of the production.
   b) Make a sketch of the scene.
   c) Make a list of necessary materials for the scene.
   d) Begin to write the portion of the script to be spoken during the scene.
   e) Submit story board to instructor for approval.

4. Print cue cards.

5. Fabricate any additional props or refine package.

6. Make background to be used in scene.

7. Prepare the script by using 8½x11" paper: divided in half vertically with information about the scene on the left side and the actual words to be spoken on the right side.

8. Reproduce the script so all members of the crew have a copy of the final script.

9. Practice rehearsals with or without videotape recording equipment.
10. Dress rehearsals filmed with the star in costume, props and background.
11. Final take planned immediately after dress rehearsals.

VIDEO TECHNIQUES:

1. Camera movement used in pursuit of a subject. Pan, tilt, dolly.
2. Zooming in and out.
3. Fade in - Fade out.
4. Focusing.
5. Adjust the lens opening for light.

STORY BOARD ACTIVITIES

A. Product Name:

B. Title of Production:

C. Sketch of Scene:

D. Materials needed for production (background - props):

1.

2.

3.

4.

5.

E. Script Narrative (commercial message as spoken by the star):

Submit story board to instructor for approval. NOTE: Story board may be several pages long.

VIDEOTAPE COMMERCIAL PROJECT EVALUATION

1. Good eye contact with the camera during production.
2. Proper facial expressions.
3. Proper body movements.
4. Proper stance.
5. Proper arm movements.
6. Proper dressing and wardrobe.
7. Realistic props and used properly.
8. Good background; solid colors, or simple layout.
9. Correct diction of words.
10. Loudness and clearness in voice.
11. Slowness of speech for clear understanding.
12. Well-written script.
13. Good camera panning.
14. Good use of tilt.
15. Proper dolly technique.
16. Proper use of zooming.
17. Good fade-in, fade-out.
18. Good framing of subject.

Definition of Terms

CAMERA OPERATOR: Must operate the camera during rehearsals and final production. Responsible for all camera movement and video portion of the final production.

DIRECTOR: The individual responsible for titling, story boarding, scriptwriting, background, and props.

DOLLY: When the camera moves closer or farther away from the subject.

PAN: Moving the camera left or right along a horizontal plane.

STAR: Must supply costume (within reason) as needed. Will be responsible for reading the script from the cue cards.

STORY BOARDING: An outline of the plan for production sequence to include title of the production, sketch of scene, necessary materials for the scene, the portion of the script to be spoken during that particular scene, and any special notes.

TECHNICAL ASSISTANT: Assists the director in any capacity needed for the production. Responsible for printing cue cards from finished script, making props, and setting up necessary items on stage, including background.

TECHNICIAN: Operates the videotape recorder and monitor. Responsible for the audio portion of the final production.

TILT: Moving the camera up or down.

Social/Environmental Impact

Does communication affect you as an individual? Of course it does! Each day you are bombarded with words or pictures from radio, television, telephone, newspapers, magazines, and even the intercom in your school although you may not always be aware of it. Communication media often transfer information that affects your emotions, values, attitudes and perceptions.

Think about what happens to your emotions when you hear an ominous voice on the school intercom calling you to the principal's office. Your values about what is right and wrong, good or bad, depend in part upon what you see and hear in the media. In other words, your perception of the real world is influenced by communication technology. In turn, your behavior depends upon what you think and feel.

Communication systems can have negative effects, also. Some people refuse to watch television news or read newspapers because the bad news depresses them. One famous newscaster, in order to counteract such fears, opens his radio broadcast each day by exclaiming, "There's good news tonight!"

Although communication certainly affects individuals, the actions of individuals in groups can also affect the methods of communication. There has been a great number of newspapers that have gone out of business in the last five years. How about record stores? Why is this happening? It may be the result, partially, of the fact that people are turning to other types of communication. Radio and television are a very real threat to newspapers because people can get information much faster. Records and newspapers are not going to disappear completely, but the days of their peak use are declining. Therefore a change in communications technology can replace jobs and create new jobs.

There are other kinds of issues that society has raised with regard to modern communication and the ways in which it is used. For example, with the growing popularity of cable television, there are more movies available in the home that have questionable subject matter. Some groups argue that this use of television cable is undermining the moral and ethical standards that are established by the family unit.

The violation of copyright laws is an example of a regulation that protects authors. With new communication technology violations of this law happen frequently. So there has to be a balance between the technical means and people using communication, as we will find ourselves in the middle of a social problem. We depend a great deal on communication (individuals and as a society.) However, it is a two-way street. Communication can change the way we live and feel about things and at the same time, society determines which means of communication will be used.

Creative Problem Solving Activities

1. Make an audio or videotape of opposing viewpoints on an issue in your school or community.
2. Have students videotape a demonstration of a safety rule in the industrial arts lab.
3. Have students prepare a videotape project for the demonstration of a machine or process in the industrial arts lab.
4. Have students prepare an industrial arts department video presentation.
5. Have manufacturing students prepare a video to sell their product or to conduct a video market survey.

Related Careers

Director

Producer

Cameraperson

Technical Assistant Director

Writer

Actor

Electronics Technician

References

Kaplan, Don. Video in the Classroom: A Guide to Creative Television. Knowledge Industry Publications, 1980.

DuVall, J.B., Maughan, G.R. Jr. and Berger, C.G. Getting the Message: The Technology of Communications. Worcester, MA; Davis Publications, 1980.

Communicating the future. Futurist, April 1981.
Communications: Dramatic Changes Ahead. Futurist, April 1978.

Haykin, S.S. Telecommunications. New York: John Wiley and Sons. 1978.

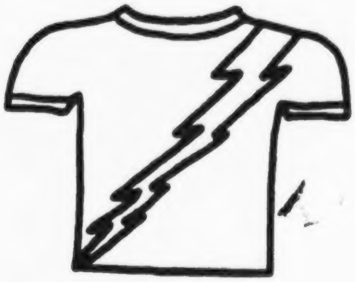
Hellman, H. Communications in the World of the Future. New York; M. Evans, 1975.

Activities for Teaching Technology

Activity Title	COMPUTERIZED T SHIRTS
Contributor	CHARLES H. MEDDAUGH
Time Required	5 HRS (1 WEEK)
Activity Description	In this activity students will learn to properly use an Apple computer. Each student will use computer graphic software to create a heat transfer that will be ironed on a T-shirt.

Terms

GRAPHIC
DOT MATRIX
MIRROR IMAGE
COLOR JUSTIFICATION
GRAPHIC COMMUNICATION
BOOT UP



Objectives

As a result of this activity the student will be able to:

start up an Apple computer following the proper procedures.

shut down an Apple computer following the proper procedures.

create computer graphics using commercial software.

create and print a heat transfer.

list several advantages of the computerized system over traditional silkscreening.

list several disadvantages of the computerized system.

Special Supplies & Equipment	Supplier
1. Apple computer	
2. Graphics printer	
3. Prince (software)	COM 6
4. other graphics software (optional)	

Transparency Masters
&
Student Handouts

COMPUTER START UP PROCEDURE:

1. Turn on all peripherals.
   A peripheral is any device connected to a computer: monitor, printer, modem, etc.
2. Holding the program disk gently by a corner and with the label up and closest to you, insert it in drive one and close the door.
3. Using the same care as above, insert a data disk in drive two.
4. Turn the computer on. The switch is located on the left rear corner of the keyboard unit.
5. Wait for the red light on the disk drive to go out.

COMPUTER SHUT DOWN PROCEDURE:

1. Carefully remove the disks from both drives and place them in their jackets.
2. Close the drive doors.
3. Turn the computer off.
4. Turn off all peripherals.

T-SHIRT DESIGN

1. Follow the computer start up procedure and boot up the Prince program.
2. Follow the directions on the screen to design a practice graphic.
3. Have the design checked by your instructor.
4. Develop a design for your T-shirt and print it using plain paper and a standard ribbon.
5. Divide the printed design into sections to be printed in different colors.
6. Make a separate graphic for each color you have chosen (two minimum, four maximum).
7. Check the justification by printing all graphics on one sheet of paper.
8. Have the print checked by your instructor.
9. Print the graphics again using the special colored printer ribbons.
10. Turn your finished product in for grading.

Definition of Terms

GRAPHIC: A picture or symbol

DOT MATRIX: A system or pattern of dots used to form letters or graphics

MIRROR IMAGE: A reversed image as would be seen in a mirror

COLOR JUSTIFICATION: The aligning of two or more, different colored segments that combine to form one picture

GRAPHIC COMMUNICATION: A method of communication through pictures and symbols

BOOT UP: Load a program from a disk and run it

Applied Math & Science Principles

MATH: X and Y coordinate systems

Social / Environmental Impact

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Creative Problem Solving Activities

PROBLEM: Mathematically create four separate color segments of a graphic using x and y coordinates, then print them as one picture to check the justification.

Related Careers

pressman

computer operator

References

Apple owners manual

Prince software manual

Activities for Teaching Technology

Activity Title CAD SYSTEM ETCHED PC BOARDS

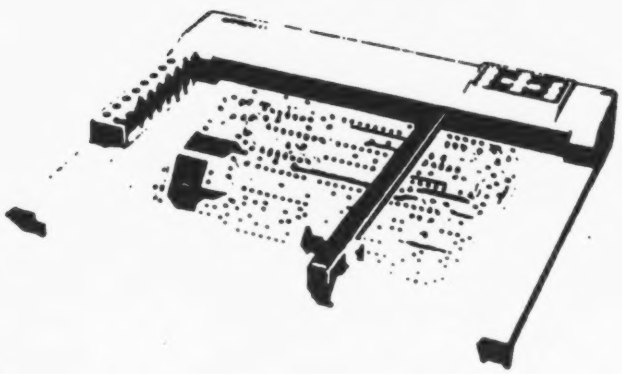
Contributor CHARLES GOSDZINSKI

Time Required

Activity Description Some of the more sophisticated low cost CAD systems used in our classrooms are capable of making directly printed circuit boards. By using a very simple procedure, your students can make PC boards without using photo techniques or manual artwork. The CAD system we use is ROBO CAD II. The system should have library features.

Terms

CAD
ETCH RESISTANT INK PEN
NC MACHINES
PC BOARD



Objectives

As a result of their learning experience students will:

develop the ability to effectively use a CAD system to design a PC board.

describe and identify the various components used in printed circuits.

design a PC board which is intended to meet the students project needs.

employ a CAD system to print the students design on a PC board.

Special Supplies & Equipment	Supplier
Printed circuit boards	COM 7 and COM 8
Etch resist ink pen	

Transparency Masters
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Student Handouts

CAD ETCHED PC BOARDS

ADVANTAGES:
1. Camera negatives are eliminated
2. More precise than manual methods
3. Error corrections and modification are easy to make
4. Drawing can be stored on diskette
5. Parts list printout can be made
6. System can be integrated with NC machine for automatic drilling.

PROCEDURE: A flat bed with only pen movement is necessary. Our plotter is provided with special holders, for the etch-resistant pen. It may be necessary to fabricate a holder that will accommodate the etch-resistant pen.

Using the library, place figures in the proper place on the grid. Use a 0.1" to 0.25" grid. Then draw the circuit lines (runs) to the pad symbol and edit so that the lines do not enter the location where the holes are to be drilled. Then widen each line to the proper run width.

Plot the drawing to determine accuracy. If everything is satisfactory, do not remove the drawing. Place a blank PC board over the plot. Plot with etch-resistant pen in holder. The PC board can then be etched and drilled.

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Definition of Terms

CAD: Computer Assisted Design.

ETCH RESISTANT INK PEN: Black felt tip pen which resists etching solution. The pen is used for making resist circuits on PC boards.

NC: Numerical Control machines.

PC: Printed Circuit.

Applied Math & Science Principles

Basic math principles

Basic electricity and electronics principles

Principles of computer assisted design (CAD)

Social / Environmental Impact

The use of developing chemicals is avoided

Production costs are reduced

Jobs are created - Jobs are lost

Overall product cost is slightly reduced

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Creative Problem Solving Activities

Design a printed circuit board, which is intended to meet the students project needs.

Design a library that allows the user to generate often used patterns (i.e. various sized components soldering pads, transistor pad diagrams, capacitor pads, typical pad spacings of 1/2 W and 1/4 W resistors.)

Related Careers

Detail Drafter

Layout Drafter

Design Drafters

Checker

Technical Illustrator

Architectual Engineering

Advertising

Indsustrial Designer

Aerospace Engineering

Ceramic Engineering

Civil Engineering

Electrical Engineering

Mechanical Engineering

References

Activities for Teaching Technology

Activity Title CADDRAW

Contributor CHARLES GOSDZINSKI

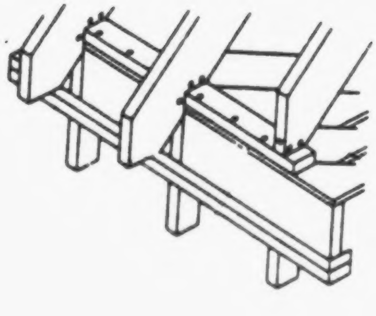
Time Required MIN 2 HRS. (MAX. 102 YRS)

Activity Description

If you're looking for a program to teach Computer Drafting, then this is the program for you. It is very affordable at $59.90. Designed specifically for teaching the principles of CAD to beginning Drafting and Design students, the CADDRAW System will allow your students to create scale drawings up to 12" x 16". CADDRAW includes most of the basic drawing commands that are used in industrial quality systems. Unlike other programs in CADDRAW price range, CADDRAW does real, accurate, scale drawings which can be stored, modified, and printed out.

Terms

- CAD
- LIBRARY
- CENTERING
- SCALE
- CATALOG
- TITLE BLOCK
- MULTI-VIEW DRAWING
- ISOMETRIC DRAWING
- PLOT DRAW
- SHAPE DRAW
- TEXT WRITING
- MEASURE RESET
- POINT SET
- ROTATE
- SAVE
- HIDDENLINE
- LINEWEIGHT
- BORDERLINE
- SYMBOLS
- SCROLL



Objectives

As a result of their learning experiences, students will:

Be able to complete a multi-view drawing.

Be able to complete an isometric drawing.

Develop an understanding of the principles of computer assisted design through use of a simplified CAD system.

Be able to determine an appropriate scale for a drawing.

Be capable of using symbols to complete a drawing.

Develop a hard copy printout of a drawing.

Special Supplies & Equipment	Supplier
1. Apple II+, IIe or IIc Computer with duo disc drive	
2. Dot matrix printer	
3. CADDRAW 4.0 program $59.90 OR	
4. CADDRAW SYSTEM $123.50 with symbol maker/editor and triple dump	COM 9
5. Robo systems	COM 10
6. Auto CAD	COM 11
7. PAXCAD	COM 12
8. MATCAD	COM 13

Transparency Masters
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Student Handouts

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What is Computer Aided Design?

Computers are tools that file, retrieve, organize, and manipulate information. They perform boring, routine tasks, leaving human beings free to do what they do best: think and create.

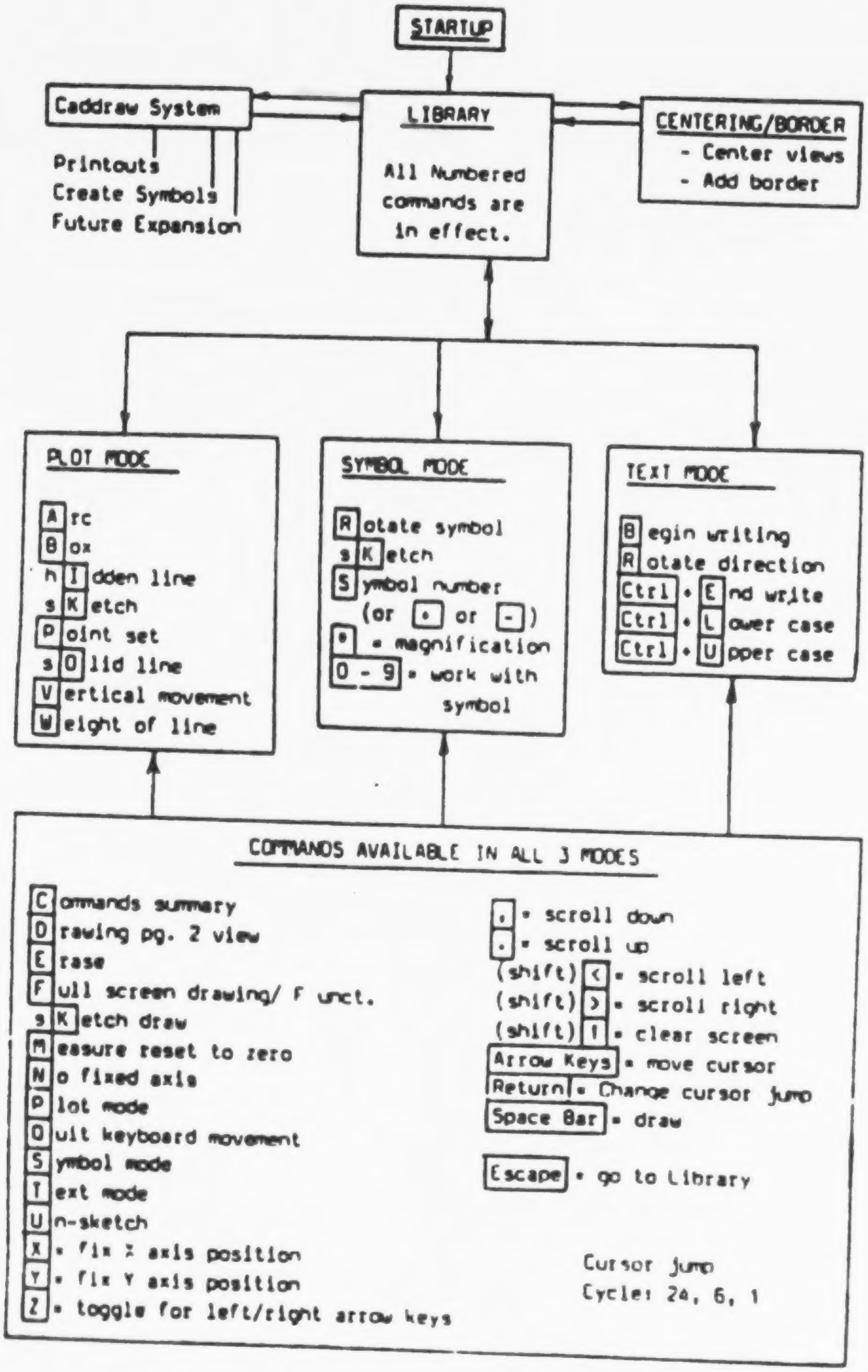
Twenty-five years ago, accountants endured the computer revolution. Today it's inconceivable for any accountant to try to keep records, or even analyze them, manually. Now, data processing technology is bringing engineers the freedom from drudgery accountants have taken for granted. Computers are automating not just sophisticated calculations, but routine tasks like drafting, bills of material preparation, and circuit board artwork generation.

Consider the ways computers are saving money and improving design schedules right now. Today's systems can:

1. Eliminate virtually all manual drafting tasks.
2. Make design revisions, even major ones, in a fraction of the time required by manual methods.
3. Build drawings quickly from a library of standard parts, then make minor changes to "customize" each drawing for the job.
4. Draft predesigned assemblies to scale automatically just by pointing with a "light pen" and keying in dimensions.
5. Produce material lists automatically from drawings.
6. Prepare numerically controlled machine tool tapes directly from your dimensioned drawings.
7. Place components on printed circuit boards, route the circuit traces to match the engineer's schematic, perform design rule checking, and prepare finished artwork and tapes for numerically controlled drills.
8. Perform engineering calculations, such as stress analysis, without the time-consuming manual task of taking dimensional information from a drawing and transferring it to a computer.

Fantastic as these achievements sound, they will seem like child's play in a decade. Enhanced computing power will allow engineers to create detailed, three-dimensional models in the "mind" of the computer, then interactively analyze them for stress, heat transfer, flexibility, and dynamic properties. Complex circuitry will be electronically modeled as easily as it is now sketched on paper and thoroughly tested before any prototypes are built.

Using criteria defined by engineers, computers will simulate and test hundreds, perhaps thousands, of possible designs, weighing factors ranging from the cost of materials and manufacturing to performance and safety. The engineering department's responsibility will no longer be just drawing production, but creation of a computer-resident data base which will drive a fully automated, computer-controlled factory.


STARTUP
Caddraw System
Printouts
Create Symbols
Future Expansion
LIBRARY
All Numbered commands are in effect.
CENTERING/BORDER
- Center views
- Add border
PLOT MODE
A rc
B ox
h I dden line
s K etch
P oint set
s O lid line
V ertical movement
W eight of line
SYMBOL MODE
R otate symbol
s K etch
S ymbol number
(or + or -)
* = magnification
0 - 9 = work with symbol
TEXT MODE
B egin writing
R otate direction
Ctrl + E nd write
Ctrl + L ower case
Ctrl + U pper case
COMMANDS AVAILABLE IN ALL 3 MODES
C ommands summary
D rawing pg. 2 view
E rase
F ull screen drawing/ F unct.
s K etch draw
M easure reset to zero
N o fixed axis
P lot mode
Q uit keyboard movement
S ymbol mode
T ext mode
U n-sketch
X = fix X axis position
Y = fix Y axis position
Z = toggle for left/right arrow keys
, = scroll down
. = scroll up
(shift) < = scroll left
(shift) > = scroll right
(shift) ! = clear screen
Arrow Keys = move cursor
Return = Change cursor jump
Space Bar = draw
Escape = go to Library
Cursor jump
Cycle: 24, 6, 1

Applied Math & Science Principles

Computer technology principle empasized

Basic math skills are reinforced

Use of scale

Addition and subtraction of fractions

Geometric shapes

Trigonometry

Symbols usedin communicating scientific ideas

Social / Environmental Impact

CAD systems are gradually working their way into high schools. It is new technology and it has been readily accepted by industry. Manufacturers have been improving their productivity. Through use of these systems. We have also only recently begun to integrate these systems with our manufacturing machines. This is known as CAM. As usual jobs will be lost, but at the same time jobs will be gained.

Creative Problem Solving Activities

One computer system is enough to introduce the entire class to CAD principles. Junior high school students can complete a drawing of their own design in a matter of minutes. This system or others can be used as a supplement to a traditional class by allowing students to team with another and spend 3-4 weeks completing a formal technical or architectural drawing. A solid three-dimensional object should be used for technical machine drawings. Use as a design supplement to technology module.

Related Careers

Detail Drafter

Layout Drafter

Design Drafter

Checker

Technical Illustrator

Architectural Engineering

Advertising

Industrial Designer

Aerospace Engineering

Ceramic Engineering

Civil Engineering

Electrical Engineering

Mechanical Engineering

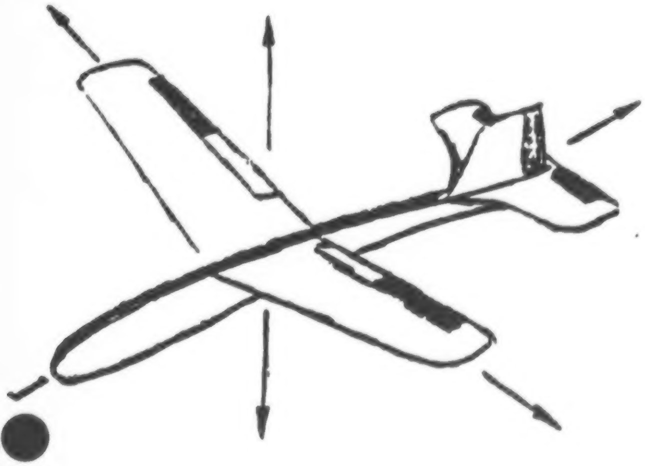
References

TRANSPORTATION

Activities for Teaching Technology

Activity Title	THEORY OF FLIGHT
Contributor	LEE E. SCHAUDE
Time Required	2 WEEKS (10 DAYS)
Activity Description	The student will construct and test various types of airfoils. The student will construct and fly an airplane with control surfaces.

Terms



- AILERON
- AIRFOIL
- ANGLE OF ATTACK
- BERNOULLI'S PRINCIPLE
- DRAG
- ELEVATOR
- FORCE
- LIFT
- PITCH
- PROPELLER
- ROLL
- RUDDER
- STABILIZER
- THRUST
- WEIGHT
- WING
- WING FLAPS
- YAW

Objectives

The student should be able to:

Describe how an airplane flies using the terms lift, gravity, thrust, and drag.

Describe how an airfoil wing creates lift.

Build a simple unpowered glider.

Demonstrate effects of balance on performance of an airplane.

Demonstrate effects of control surfaces on flight of aircraft.

Describe the major parts of an airplane and how airplanes are constructed.

Explain how control surfaces are used to turn and make an aircraft climb or dive.

Special Supplies & Equipment	Supplier
Balsa wood 2mm thick	
1/8" soft wire	
File folders of heavy paper	
Electric fan	
Balance	
Rule	
Wire Cutters	
Scissors	
Tape	
White glue	

Transparency Masters
&
Student Handouts

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AIRFOIL TESTING EXERCISE

DIRECTIONS

1. CUT FOUR (4) IDENTICAL SHAPES OF EACH OF THE SUGGESTED AIRFOIL DESIGNS. MAKE SURE THAT EACH OF THE FOUR PIECES ARE THE SAME SHAPE AND SIZE.

2. ASSEMBLE THE 4 DIFFERENT AIRFOILS AS SHOWN IN AIRFOIL ASSEMBLY EXAMPLE USING WHITE GLUE AND DITTO PAPER.

3. USING WIRE CUTTERS AND PLYERS, CUT AND SHAPE 1/8 SOFT WIRE TO MAKE A TEST STANT AS SHOWN IN DIAGRAM ON TEST ASSEMBLY ON BALANCE.

4. TEST EACH OF THE AIRFOILS ON THE BALANCE AS FOLLOWS:

   A. ATTACH AIRFOIL TO PLATE OF BALANCE.

   B. ADJUST BALANCE TO ZERO.

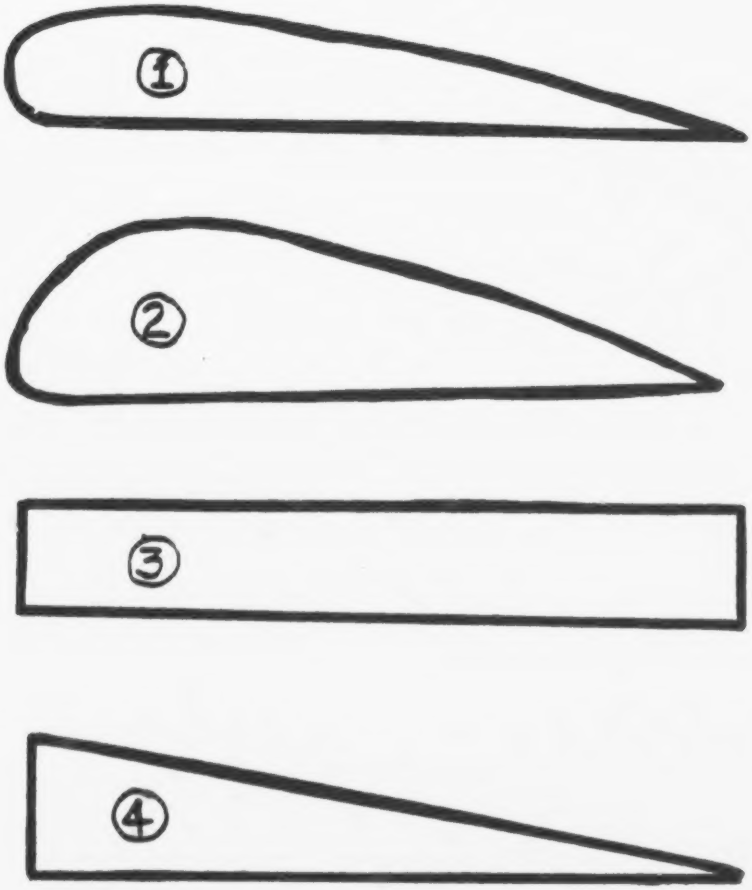
   C. PLACE AN ELECTRIC FAN ONE METER IN FRONT OF BALANCE AND RUN AT SLOW SPEED.

   D. WITH FAN RUNNING, READ THE LIFT OF EACH AIRFOIL ON THE SCALE OF THE BALANCE.

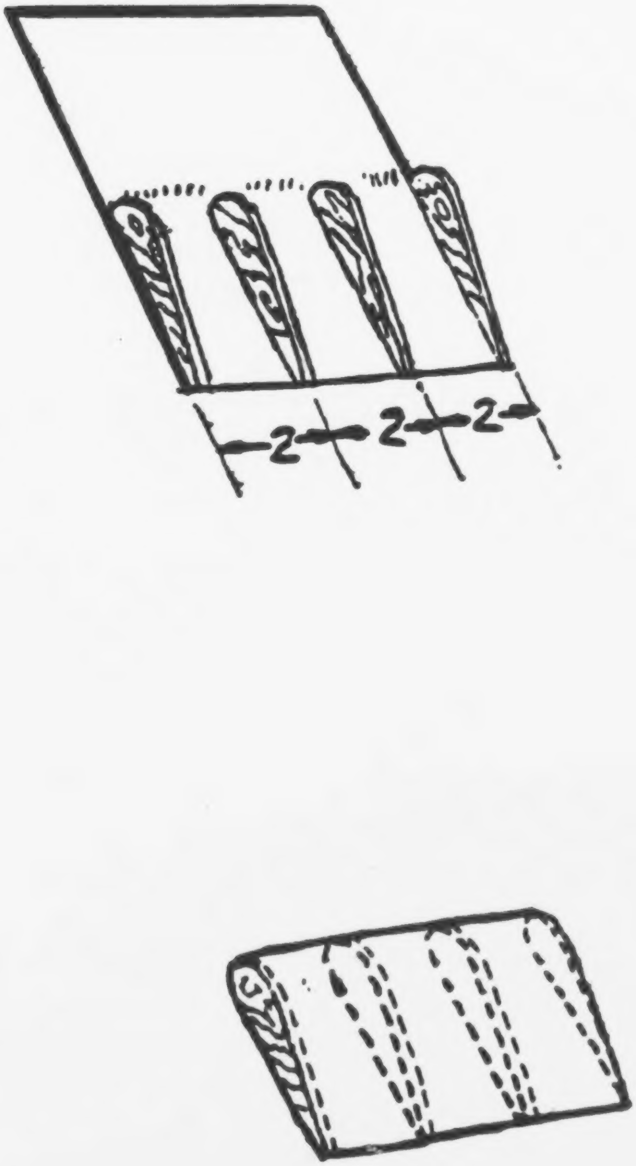
   E. RECORD DATA BELOW.

   F. WRITE A SUMMARY OF YOUR FINDINGS.

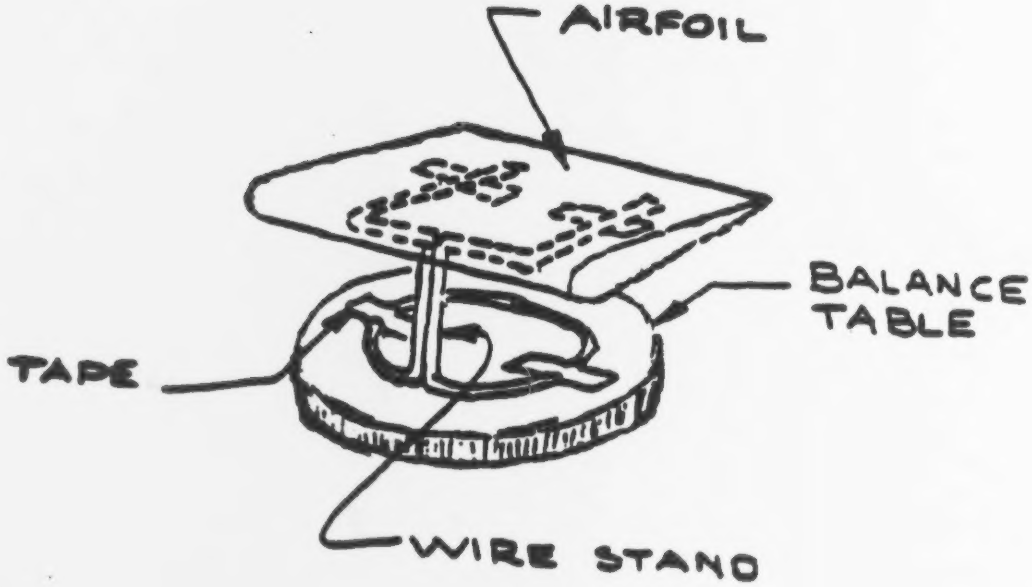
AIRFOIL	DISTANCE FROM FRONT TO BACK OF AIRFOIL	LIFT MEASURED
1		
2		
3		
4		



TEST AIRFOILS



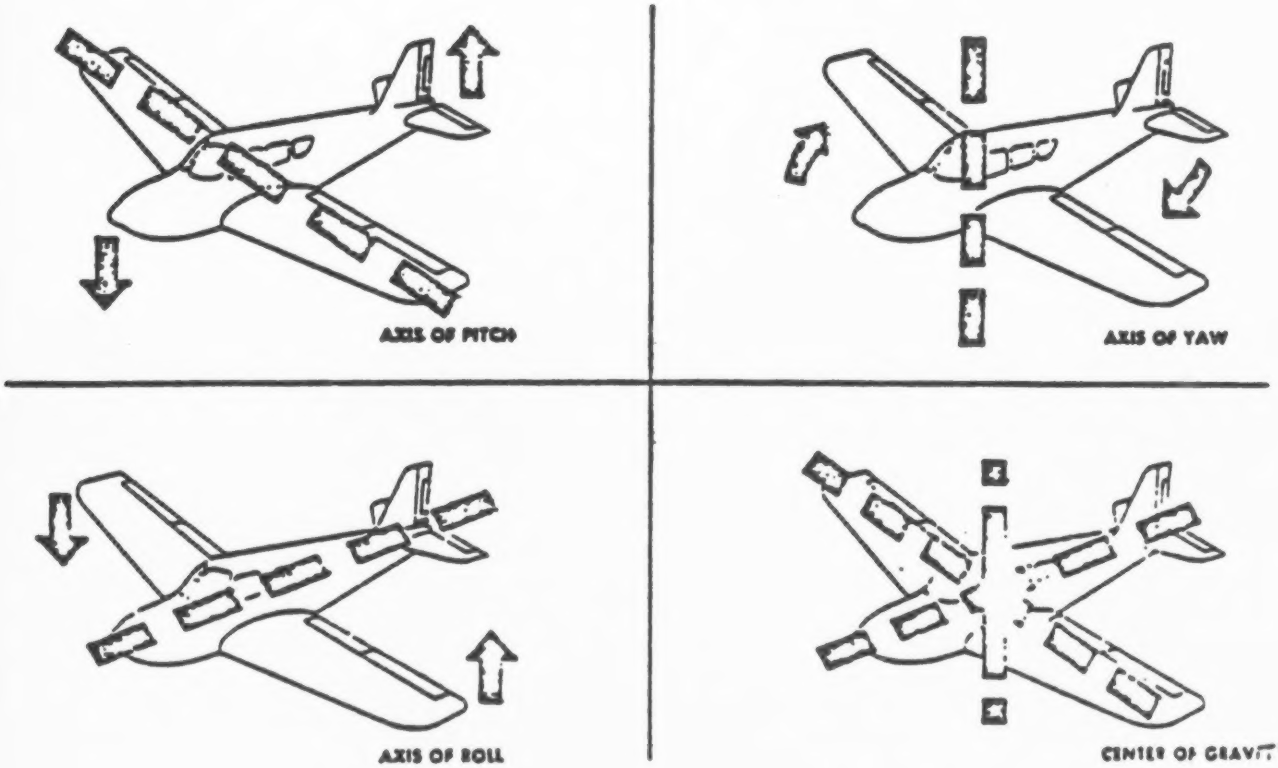
AIRFOIL ASSEMBLY EXAMPLE


AIRFOIL
BALANCE TABLE
TAPE
WIRE STAND

TEST ASSEMBLY ON BALANCE

ATMOSPHERIC TRANSPORTATION - HEAVIER THAN AIRCRAFT

Directional Control of an Aircraft



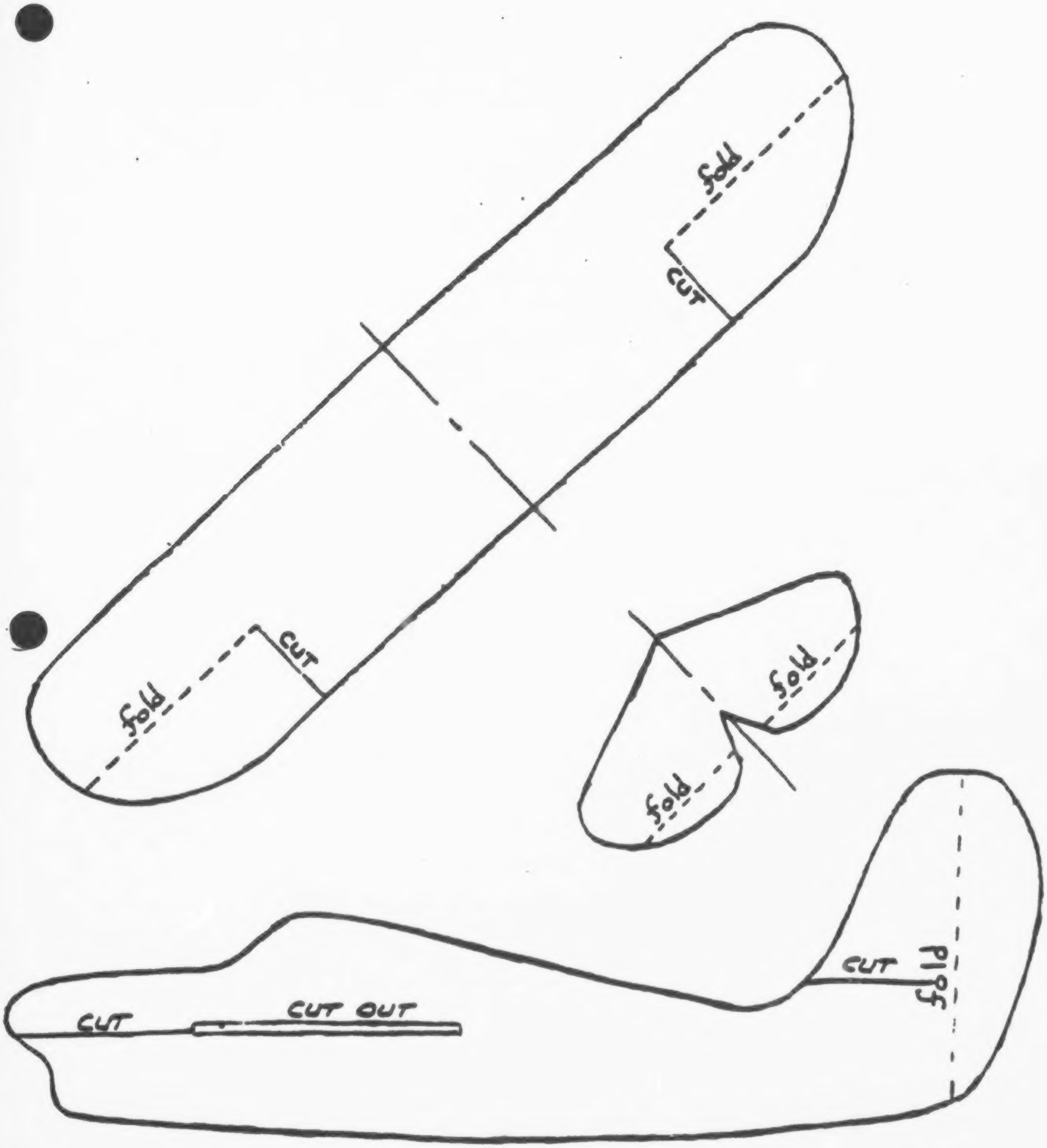
Three Axes of Rotation

An airplane is free to turn in three planes. It has three axes of rotation all passing through the center of gravity. Each axis is controlled by a moveable part of the aircraft's super structure.

Assignment:

Construct the paper airplane according to instructions. Test fly your aircraft and attempt to determine what controls each axis of rotation on your aircraft.

Modify your aircraft so that you can control direction.


fold
CUT
fold
CUT
fold
fold
CUT
CUT OUT
CUT
fold

PAPER AIRPLANE

1. CUT EACH OF THE SHAPES IN THE PAPER AIRPLANE PATTERN ON HEAVY TAGBOARD STOCK.

2. CUT ON DESIGNATED LINES.

3. FOLD ON DESIGNATED FOLD LINES.

4. SLIDE WING AND STABILIZER INTO SLOTS AND ATTACH WITH WHITE GLUE AND ALLOW TO DRY. BE CAREFUL WHEN STORING TO DRY THAT WING AND STABILIZER ARE SQUARE TO BODY.

5. FLY AIRPLANE MAKING DIFFERENT ADJUSTMENTS TO CONTROL SURFACES:

   A. AILERONS

   B. RUDDER

   C. ELEVATOR

6. MAKE ADJUSTMENTS TO CONTROL SURFACES TO MAKE AIRPLANE:

   A. INCREASE PITCH AND CLIMB.

   B. ROLL TO THE LEFT.

   C. COMBINATION OF PITCH, YAW, AND ROLL.

Definition of Terms

AILERON:	The control surfaces on the back of the wing near tips that controls the roll of the aircraft.
AIRFOIL:	A shape which causes an upward force as air flows over the shape.
ANGLE OF ATTACK:	The angle at which the flow of air hits the airfoil.
BERNOULLI'S PRINCIPLE:	Air pressure is indirectly proportional to its velocity over a surface.
DRAG:	Air resistance on a moving object.
ELEVATOR:	Control surface on an elevator that controls the pitch of an aircraft.
FORCE:	Pushes and pulls on an aircraft (lift/weight, thrust/drag).
LIFT:	An upward force on an airfoil.
PITCH:	The movement of the nose of an aircraft up and down.
PROPELLOR:	A blade that moves air to provide thrust to an aircraft.
ROLL:	The movement of an aircraft that causes one wing to rotate higher or lower than the opposite wing.
RUDDER:	The upright moveable flap at the rear of an aircraft that controls the yaw of the aircraft.
STABILIZER:	The rear wing on an aircraft that houses the elevators.
THRUST:	The force that moves an object forward.
WEIGHT:	The pull of gravity on an object.
WING:	The large forward airfoil on an aircraft positioned near the front.
WING FLAPS:	The moveable parts on rear of the wings to increase the lift of the airfoil.
YAW:	The movement of an aircraft in the direction of left and right.

Applied Math & Science Principles

Measuring axis, timing

Interpretation of what we see

What are the four forces needed to explain how an aircraft flies?

How does Bernoulli's principle help to explain aircraft flight?

What is needed to provide thrust for an airplane?

Social/Environmental Impact

Rapid transportation of goods; materials and people

Air transportation as increased possible work and home location to be thousands of miles apart.

Cosmopolitan world

Creative Problem Solving Activities

1. Collect various types of airplane models for display. Explain certain unique features of particular types of airplanes. Compare the shape and surface area of wings, size of engines, and shape of fuselages. Note the positions of control surfaces on each plane.

2. Design and fabricate paper airplanes and compete for:

    A. The longest time in the air.
    B. The greatest distance traveled.
    C. The highest distance above the ground achieved.
    D. The most aerobotic.

3. See who can construct the smallest and the largest paper airplane that will fly.

4. Design a mechanical launch system for paper airplanes that will give each airplane the same thrust in the competitive activities in activities #2 and #3.

5. Using styrofoam and/or cardboard, see who can build the heaviest airplane that will fly 30 meters.

6. Design and fly a paper airplane through an obstacle course designed by your instructor.

7. Design and fabricate a device using smoke or water vapor to show the air flow over an airfoil.

8. Use the Airfoil computer program and design an airfoil to be tested in the device constructed in activity #7.

Related Careers

Aeronautical Engineer

Air Traffic Controller

Aircraft Mechanic

Airplane Pilot

Astrophysists

Aviation Inspector

Flight Engineer

Industrial Designer

Mechanical Engineer

Meterologist

NASA Employee

Physical Scientist

Technologist

References

Magnoli, Michael, A.; *Experiences in Physical Science*. Laidlow Brothers River Forest, IL; 1985.

Jensen, Mike; *Rice Lake Curriculum Guide for Technology Education*; Rice Lake High School; Rice Lake, WI.

Airfoil, Apple Computer, Inc., 1978.

Activities for Teaching Technology

Activity Title MODEL ROCKETRY (AEROSPACE TRANSPORT.)

Contributor LEE E. SCHAUDE

Time Required 2½ - 3 WEEKS (15 - 21 DAYS)

Activity Description

1. The student will construct and fly a model rocket in accordance with Model Rocektry Safety Code.
2. Students will design and fabricate a device to aid in the calculations of determining the height their model rocket flew.

Terms

ACCELERATION
ALTISCOPE
ANGULAR DISTANCE
APOGEE
AVERAGE THRUST
BODY TUBE
CENTER OF GRAVITY
ENGINE (MODEL ROCKET)
FINS
IGNITER
IMPULSE
LAUNCH LUG
NEWTON
NEWTON-SECOND
NOSE CONE
PARACHUTE
RECOVERY SYSTEM
SHOCK CORD
SHROUD LINE
TANGENT
VELOCITY

Objectives

The student should be able to:

Describe how rockets are constructed.

Describe how the flight of rockets is controlled.

Design a model rocket.

Fabricate a model rocket.

Test model rocket for stability.

Calculate the height the model rocket flew using an altiscope and a trigonometry formula.

Special Supplies & Equipment	Supplier
Model Rocket Kits Engines, Tubes, Igniters and etc.	TRANS - 1
Ditto Paper	
Gummed Packaging Tape	
White Glue	
Corrugated Cardboard or Balsa wood 3mm thick	
Corks or Balsa block	
3/16" dia. Soda Straws	
Straight pins	
Clay	
Large Rubber Bands	
Paint	
Decals	
Magic Markers	

Transparency Masters
&
Student Handouts

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ROCKET FABRICATION DIRECTIONS

BODY TUBE (SEE FIGURE 1)

1. WRAP DITTO PAPER AROUND A ONE INCH DOWEL ROD AND APPLY WHITE GLUE AT OUTSIDE SEAM.
2. CUT ANGLE ON END OF GUMMED TAPE. MOISTEN TAPE AND WRAP TAPE ENTIRE LENGTH OF DITTO PAPER.
3. APPLY SECOND LAYER OF GUMMED TAPE IN THE SAME MANNER AS STEP 2 BUT WRAP TAPE IN OPPOSITE DIRECTION THAN THE FIRST LAYER.
4. WHEN DRY, SLIDE BODY TUBE OFF DOWEL ROD AND TRIM TO 245 mm.

ENGINE HOUSING (SEE FIGURE 2)

1. GLUE TWO EXPENDED ROCKET ENGINES END TO END.
2. CUT DITTO PAPER TO 80mm, WRAP PAPER AROUND EXPENDED ENGINES AND GLUE AT THE SEAM.
3. CUT THREE 3mm WOOD STRIPS AND GLUE 120° DEGREES APART TO THE CIRCUMFERENCE ON ENGINE HOUSING.
4. CUT ENGINE HOUSING AND ATTACH ENGINE HOOK SO THAT END OF ENGINE HOOK EXTENDS 5mm FROM END OF ENGINE HOUSING.

FINS (SEE FIGURE 3)

1. CUT 3 FINS FROM 3mm BALSA WOOD.
2. SHAPE FINS SO ALL THREE PIECES ARE THE SAME SHAPE AND SIZE.
3. TAPER LEADING EDGE OF FINS.

NOSE CONE (SEE FIGURE 4)

1. CUT OR CARVE ROUGH SHAPE OF NOSE CONE FROM 26mm X 26mm X 50 mm BALSA WOOD BLOCK.
2. CAUTION: TRIM LARGE END OF BLOCK TO CYLINDER THAT WILL FIT SNUG INTO THE BODY TUBE.
3. INSTALL SCREW EYE TO CENTER OF REAR OF NOSE CONE.
4. SAND TO FINAL SHAPE.

PARACHUTE (SEE FIGURE 5)

1. CUT BLACK PLASTIC GARBAGE BAG TO A 400mm HEXAGON.
2. CUT 6 STRINGS TO 400mm IN LENGTH AND KNOT TOGETHER AT ONE END.
3. TAPE FREE ENDS OF STRING TO CORNERS OF HEXAGON PARACHUTE.

ASSEMBLY (SEE FIGURES 6&7)

1. GLUE ENGINE HOUSING INTO BODY TUBE SO THE BACK OF ENGINE HOUSING IS FLUSH WITH BODY TUBE.
2. GLUE FINS TO BODY TUBE SPACING THEM 120 DEGREES APART ON THE BACK OF BODY TUBE.
3. ATTACH SHROUD LINES AND SHOCK CORD TO SCREW EYE ON NOSE CONE.
4. GLUE SHOCK CORD TO INSIDE OF BODY TUBE 30mm BELOW END OF TUBE.
5. ATTACH LAUNCH LUG ADJACENT TO FIN.

FINISHING

PAINT AND APPLY DECALS OR DECORATIONS WITH MAGIC MARKERS AS DESIRED.

SPECIAL NOTES TO TEACHER

1. IF ENGINE HOOKS ARE UNAVAILABLE, YOU MAY USE A STRAIGHT PIN THROUGH THE BODY TUBE ABOVE AND BELOW THE ENGINE TO SECURE ENGINE.
2. SANDING SEALER AND LIGHT SANDING WILL INCREASE THE QUALITY OF THE FINISH.
3. USE ONLY TYPE A ENGINES FOR ROCKETS ASSEMBLED FROM SCRATCH.
4. FOLLOW SAFETY RULES FOR LAUNCHING. (FIGURE 8).

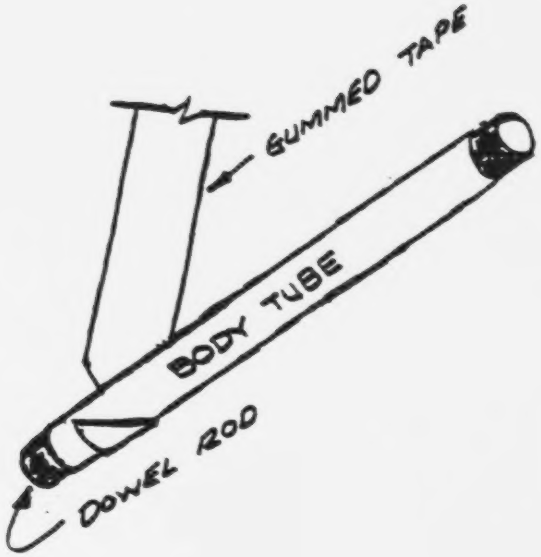

GUMMED TAPE
BODY TUBE
DOWEL ROD

FIGURE 1

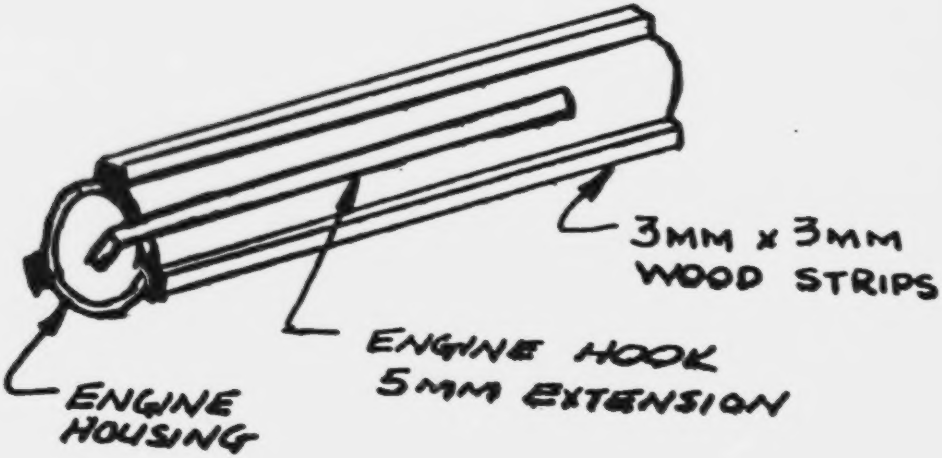

3MM x 3MM
WOOD STRIPS
ENGINE HOOK
5MM EXTENSION
ENGINE
HOUSING

FIGURE 2.

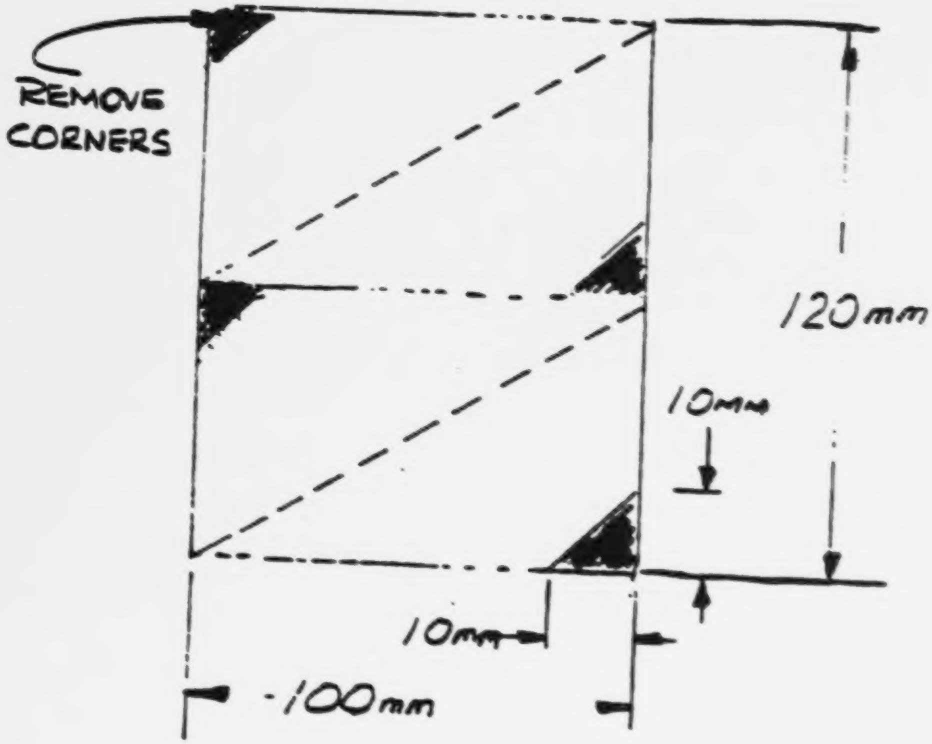

REMOVE CORNERS
120mm
10mm
10mm
100mm

FIGURE 3

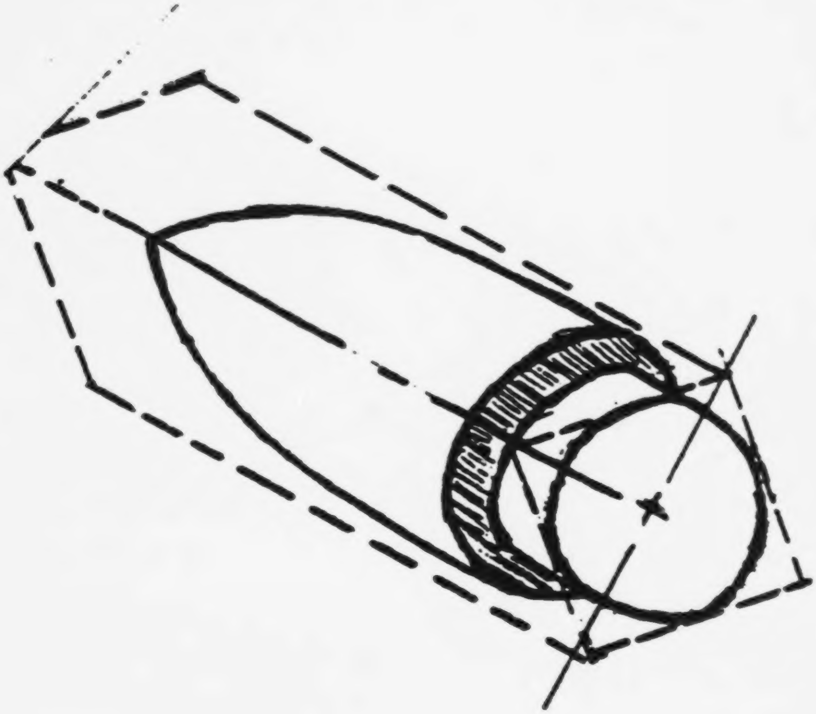


FIGURE 4

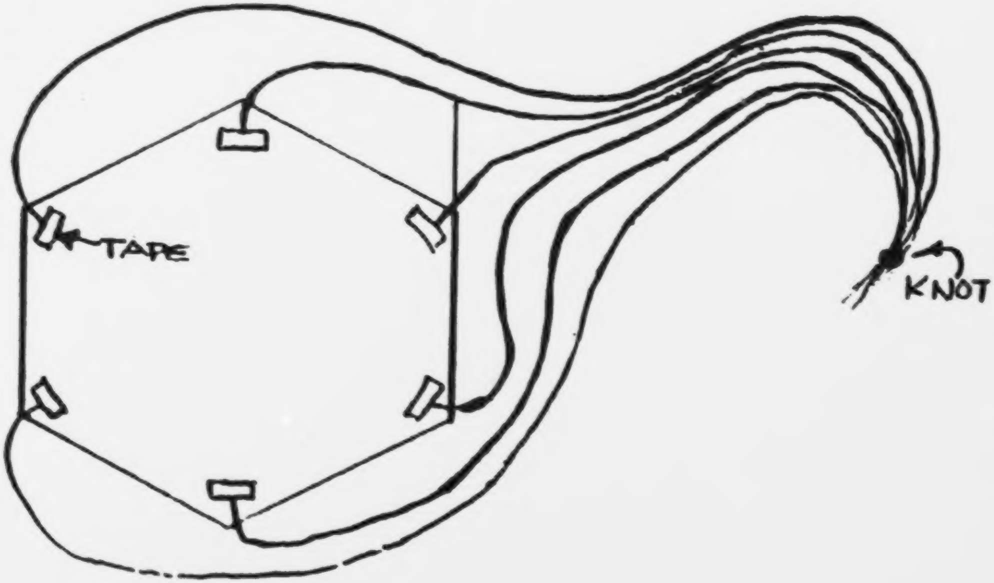


FIGURE 5.

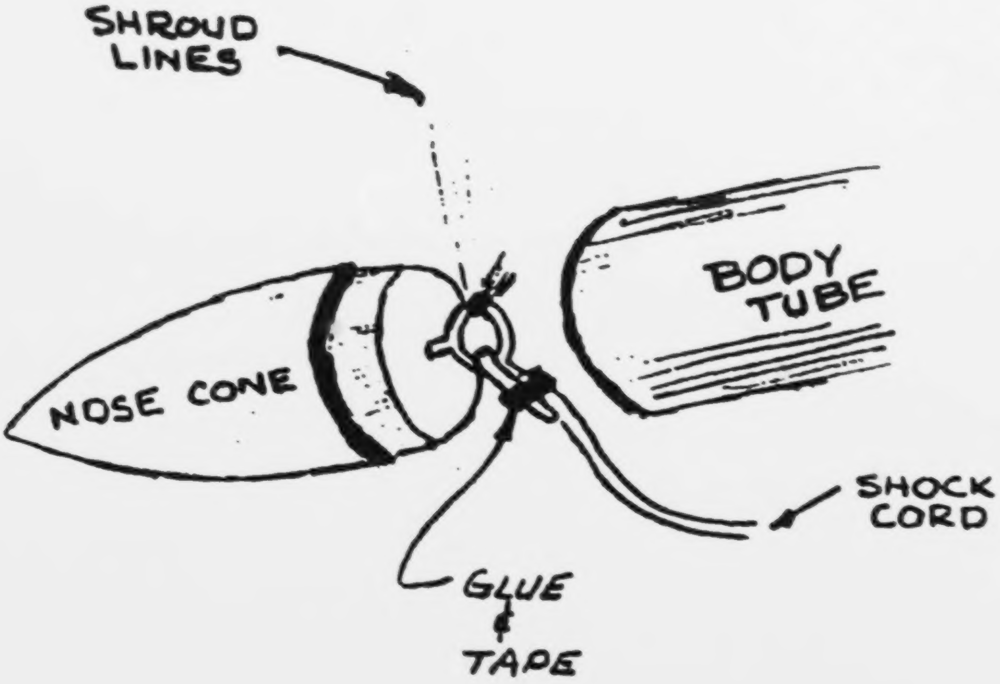

SHROUD LINES
BODY TUBE
NOSE CONE
SHOCK CORD
GLUE & TAPE

FIGURE 6

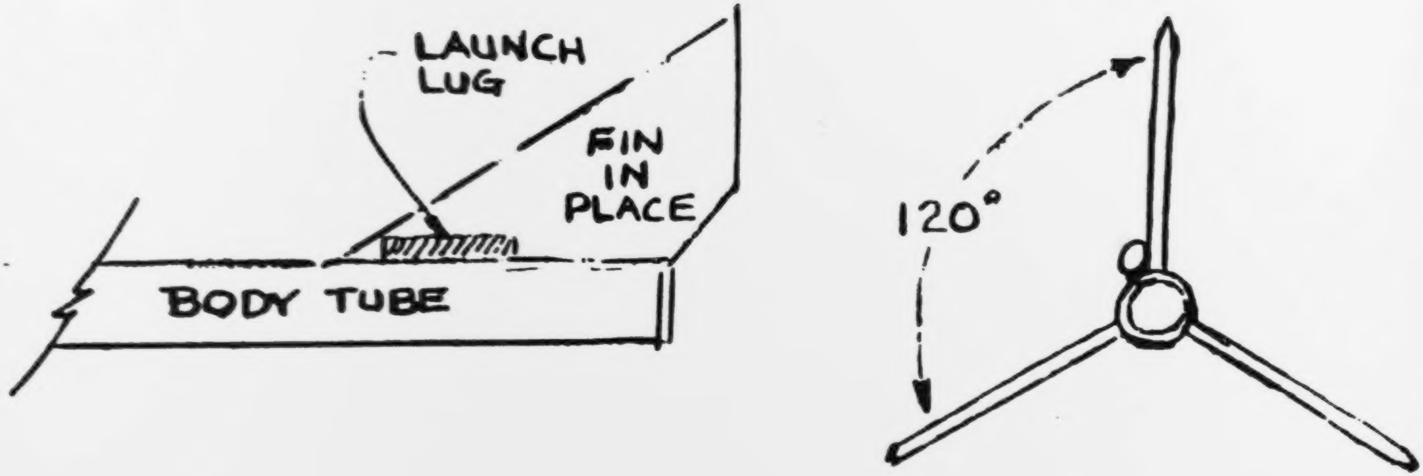

LAUNCH
LUG
FIN
IN
PLACE
BODY TUBE
120°

FIGURE 7

TM-16 ESTES A DAMON COMPANY

Industrial Arts Model Rocketry

SOLID PROPELLANT

Model Rocketry Safety Code

1. **Construction** — My model rockets will be made of lightweight materials such as paper, wood, plastic and rubber, without any metal as structural parts.

2. **Engines** — I will use only pre-loaded factory made model rocket engines in the manner recommended by the manufacturer. I will not change in any way nor attempt to reload these engines.

3. **Recovery** — I will always use a recovery system in my model rockets that will return them safely to the ground so that they may be flown again.

4. **Weight Limits** — My model rocket will weigh no more than 453 grams (16 ozs.) at liftoff, and the engines will contain no more than 113 grams (4 ozs.) of propellant.

5. **Stability** — I will check the stability of my model rockets before their first flight, except when launching models of already proven stability.

6. **Launching System** — The system I use to launch my model rockets must be remotely controlled and electrically operated, and will contain a switch that will return to "off" when released. I will remain at least 15 feet away from any rocket that is being launched.

7. **Launch Safety** — I will not let anyone approach a model rocket on a launcher until I have made sure that either the safety interlock key has been removed or the battery has been disconnected from my launcher.

8. **Flying Conditions** — I will not launch my model rocket in high winds, near buildings, power lines, tall trees, low flying aircraft, or under any conditions which might be dangerous to people or property.

9. **Launch Area** — My model rockets will always be launched from a cleared area, free of any easy to burn materials, and I will only use non-flammable recovery wadding in my rockets.

10. **Jet Deflector** — My launcher will have a jet deflector device to prevent the engine exhaust from hitting the ground directly.

11. **Launch Rod** — To prevent accidental eye injury I will always place the launcher so the end of the rod is above eye level or cap the end of the rod with my hand when approaching it. I will never place my head or body over the launching rod. When my launcher is not in use I will always store it so that the launch rod is not in an upright position.

12. **Power Lines** — I will never attempt to recover my rocket from a power line or other dangerous places.

13. **Launch Targets & Angle** — I will not launch rockets so their flight path will carry them against targets on the ground, and will never use an explosive warhead nor a payload that is intended to be flammable. My launching device will always be pointed within 30 degrees of vertical.

14. **Pre-Launch Test** — When conducting research activities with unproven designs or methods, I will, when possible, determine their reliability through pre-launch tests. I will conduct launchings of unproven designs in complete isolation from persons not participating in the actual launching.

This Solid Propellant Model Rocketry Safety Code is Approved by The National Association of Rocketry and the Hobby Industry Association of America.

FIGURE 8

MATH CALCULATIONS

The first mathematical calculations you will make to complete this assignment is to figure the altitude (how high) your rocket flew. You will do this with the aid of an altiscope. Follow the steps below and you will find that it is easy, well, almost easy.

1. Locate the altiscope 100 meters from your launch site.
2. Track the flight of your rocket with the altiscope and record the angular reading.
3. Find the tangent of the angle you recorded for the apogee of your rocket and record.
4. Use the records from step 2 and 3 to solve the following problem that tell you the altitude your rocket reached.

ALTITUDE = DISTANCE FROM LAUNCH X TANGENT OF ALTITUDE ANGLE

OR

$$A = D \times \angle a \text{ TAN}$$

EXAMPLE FOR $\angle a = 52°$

$$A = D \times \angle a$$

$$A = 100\text{m} \times 1.28$$

$$A = 128 \text{ meters}$$

The second calculation on the flight of your rocket will be for maximum velocity, which is the top speed your rocket obtains before it begins to slow down. This is will be done with the folowing assumptions, 1. there is no friction or air resistance, and 2. positive acceleration during engine burn time and then constant velocity.

t_1 = ENGINE BURN TIME (GIVEN IN ENGINE INFORMATION SHEET)

t_2 = CONSTANT VELOCITY TIME (TIME TO APOGEE)

V = VELOCITY

D = ALTITUDE

$$\left(\frac{1}{2}t_1 + t_2\right)V = D$$

$$V = \frac{D}{\left(\frac{1}{2}t_1 + t_2\right)}$$

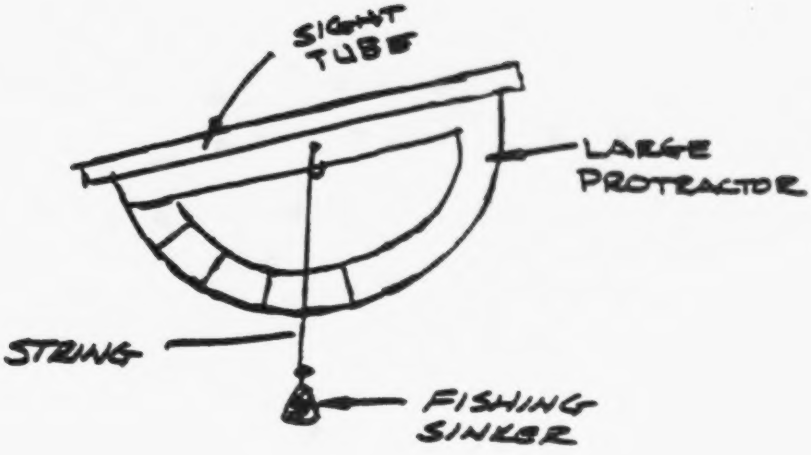
EXAMPLE

$$V = \frac{128 \text{ meters}}{\left(\frac{1}{2} \times 5\right) + (2\text{sec})}$$

$$V = \frac{128 \text{ meters}}{(2.5s)(2\text{sec})}$$

$$V = 25.6 \text{ meters/sec}$$

ALTISCOPE IDEAS —


SIGHT TUBE
LARGE PROTRACTOR
STRING
FISHING SINKER

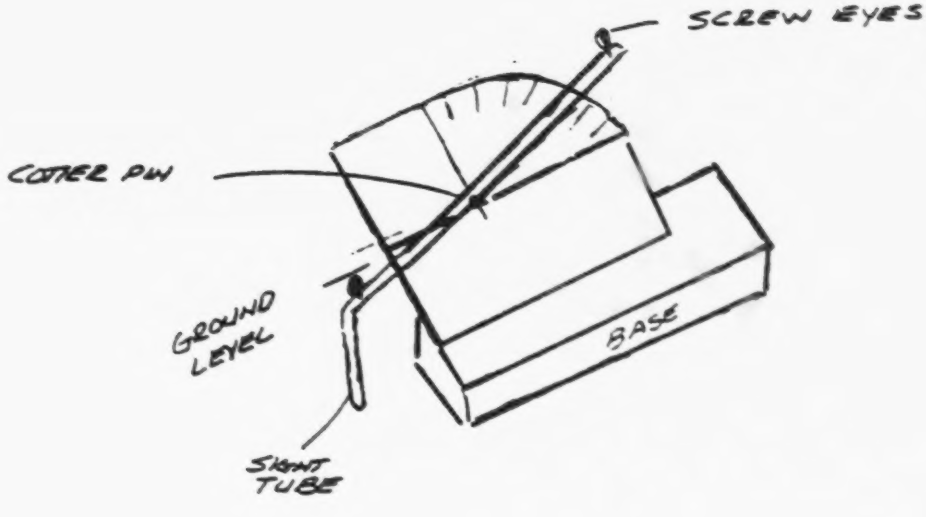

SCREW EYES
COTTER PIN
GROUND LEVEL
BASE
SIGHT TUBE

TABLE OF TANGENTS

Angle	Tan.	Angle	Tan.	Angle	Tan.
1°	.02	28°	.53	54°	1.38
2	.03	29	.55	55	1.43
3	.05	30	.58	56	1.48
4	.07	31	.60	57	1.54
5	.09	32	.62	58	1.60
6	.11	33	.65	59	1.66
7	.12	34	.67	60	1.73
8	.14	35	.70	61	1.80
9	.16	36	.73	62	1.88
10	.18	37	.75	63	1.96
11	.19	38	.78	64	2.05
12	.21	39	.81	65	2.14
13	.23	40	.84	66	2.25
14	.25	41	.87	67	2.36
15	.27	42	.90	68	2.48
16	.29	43	.93	69	2.61
17	.31	44	.97	70	2.75
18	.32	45	1.00	71	2.90
19	.34	46	1.04	72	3.08
20	.36	47	1.07	73	3.27
21	.38	48	1.11	74	3.49
22	.40	49	1.15	75	3.73
23	.42	50	1.19	76	4.01
24	.45	51	1.23	77	4.33
25	.47	52	1.28	78	4.70
26	.49	53	1.33	79	5.14
27	.51			80	5.67

Definition of Terms

ACCELERATION: To move faster and faster during each second of motion.

ALTISCOPE: A device used to measure angular height.

ANGULAR DISTANCE: The distance the altiscope is placed from launch point.

APOGEE: The highest point above the earth a rocket reaches.

AVERAGE THRUST: The total impulse of a rocket engine divided by the time duration of its thrust.

BODY TUBE: The cylinder which is the main frame of a model rocket.

CENTER OF GRAVITY: The point on an object where it may be balanced on a knife edge.

ENGINE (model rocket): A ceramic holder in which propellant is burned.

FINS: The stabilizing surfaces on rockets which are symmetrically spaced.

IGNITER: An electrical device which initiates the burning of engine propellant.

IMPULSE: The propelling force from burning propellant caused by a rearward ejection of gasses.

LAUNCH LUG: A guide tube for launch rod fastened to body tube of rocket.

NEWTON: The force needed to move 1 kilogram 1 meter per second each second.

NEWTON-SECOND: A measurement for engines total impulse.

NOSE CONE: The forward surface on a rocket shaped to allow the stream.

PARACHUTE: A film type material that will shape like an umbrella to help retard the fall of an object.

PROPELLANT: A combustable material in the model rocket engine that is burned in a controlled manner.

RECOVERY SYSTEM: The method used to safely return rocket to earth.

SHOCK CORD: A cord that absorbs the shock when the recovery system is deployed.

SHROUD LINE: The lines attaching the recovery system to the rocket.

TANGENT: The ratio of length of the opposite side of a triangle to the side connecting the angle to the opposite side.

VELOCITY: Feet per second or meter per second speed.

Applied Math & Science Principles

Newton's Laws of Motion

Stability

Center of Gravity

Acceleration - velocity

Thrust

Simple Electrical Circuits

Observations - Recording

Triangulation

Measuring

Calculations

Social/Environmental Impact

Human and goods space transportation

1. Space colonies
2. Weapons
3. Research
4. Exploration of universe
5. By-products of space research

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Creative Problem Solving Activities

1. Design and fabricate a multi-staged rocket.
2. Design and fabricate a multi-engined rocket.
3. Design and fabricate a rocket that will carry a payload of a raw egg and return it unbroken to earth.
4. Design and build a rocket that will carry a payload of a camera or electronic equipment.
5. Design and build a wind tunnel to help check the stability of model rockets.
6. Design and build a launch system that is capable of launching 1, 2, 3, or 4 rockets at a time.
7. Design and build a rocket that will have a lighted nose cone that can be launched and tracked at night.
8. Catch various insects, examine them and record observations. Launch the insects as the payload in a model rocket. Examine and record your observations. Compare your observations from pre-launch and post-launch.

Related Careers

Aerospace Engineer

Air Traffic Controller

Aircraft Mechanic

Airplane Pilot

Astrophysicists

Aviation Inspector

Flight Engineer

Industrial Designer

Mechanical Engineer

Meteorologist

NASA Employee

Photography

Physical Scientist

Technologist

References

Estes Industry Publications:

The Alpha Book of Model Rocketry, 1976

Cannon, Robert; Model Rocketry; 1977

Cannon, Robert; The Laws of Motion and Model Rocketry; 1979

Cannon, Robert; Elementary Mathematics of Model Rocket Flight; ?

Smith, Harry & Warden, Harry; Industrial Arts Teachers Manual for Model Rocketry; 1980.

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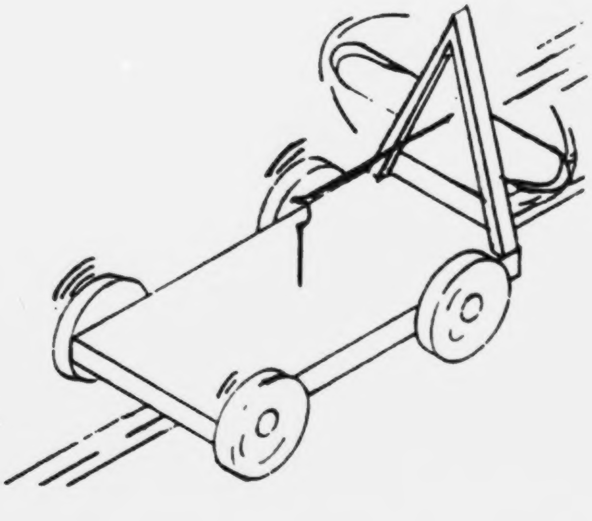
Activities for Teaching Technology

Activity Title	FLYING ON LAND
Contributor	CHARLES GOSDZINSKI
Time Required	1 SEMESTER (approximately)
Activity Description	This activity involves the development of a propeller-driven car. The activity can be used to build a small scale working model of the students own design or used to build a prototype capable of carrying a 185 lb. person. A study of aircraft piston engines and propellers is necessary if a propeller is employed. Since the propeller must be a fixed one, the blade angle cannot be adjusted during operation.

Terms

- AIRFOIL
- PROPELLER
- PULLEY
- GAUGE
- WHEELBASE
- AERODYNAMIC
- HOVERCRAFT



Objectives

As a result of their learning experiences, students will be able to:

Develop problem solving abilities.

Understand the importance and meaning of a prototype.

Develop material processing abilities necessary to construct the prototype.

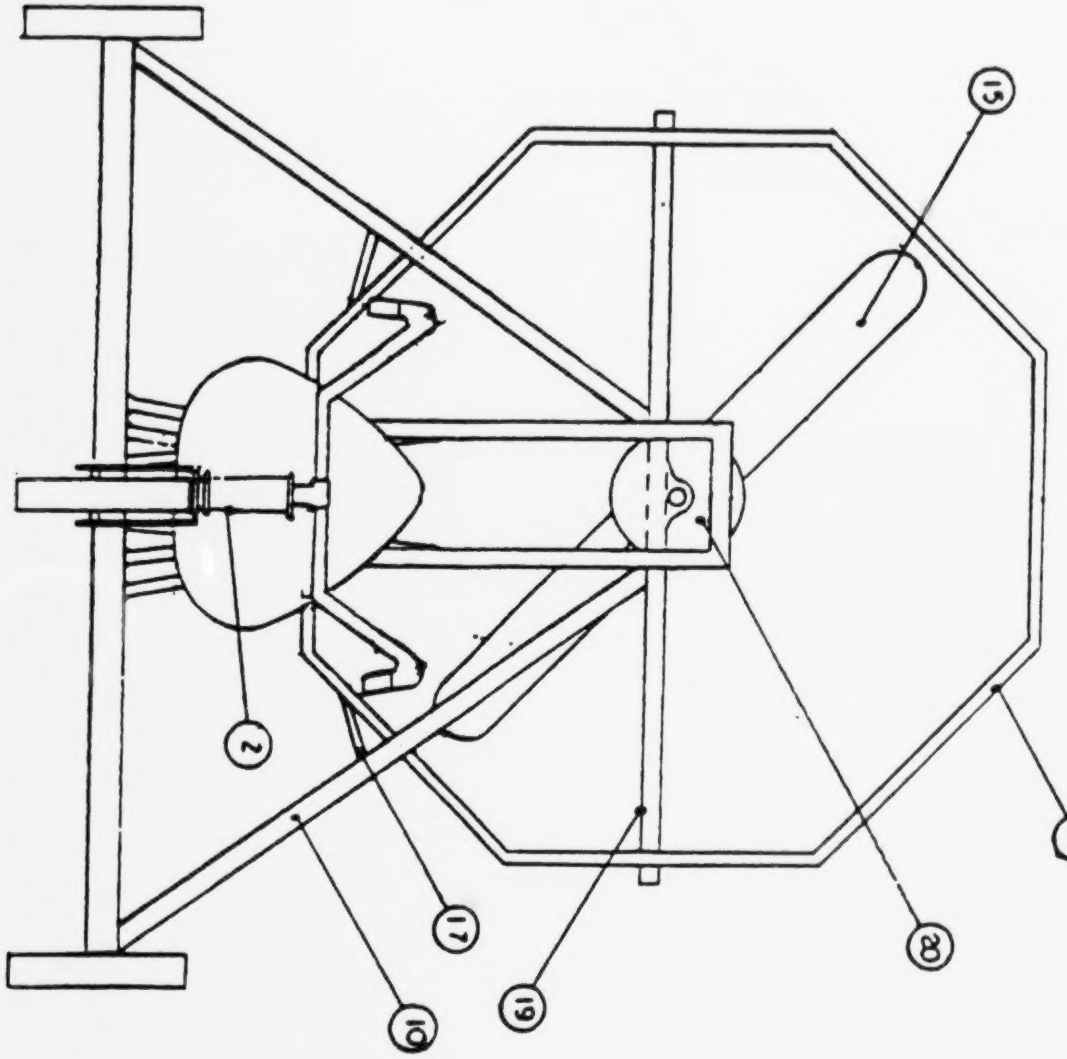
Determine the difference between proper and improper design materials.

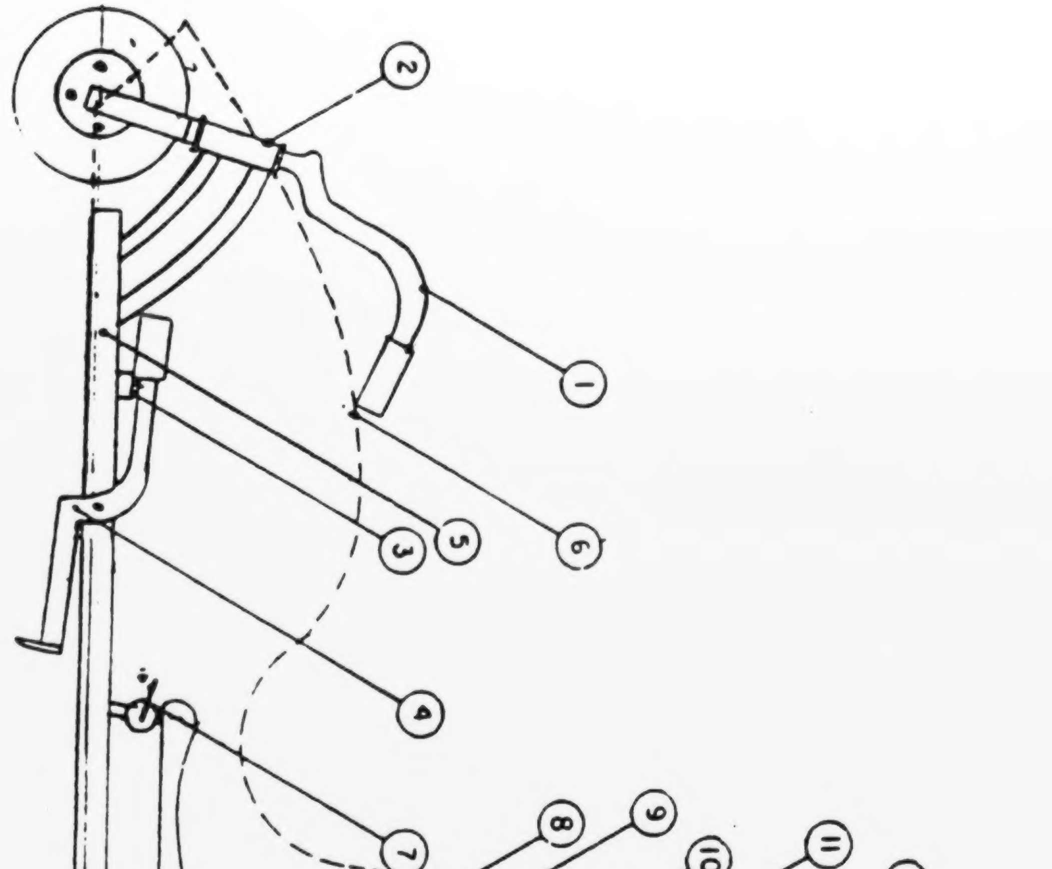
Understand basic principles of aircraft engines and propellers.

Determine optimum blade pitch angle relative to the power or the engine.

Special Supplies & Equipment

Supplier





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Flying on land?!

THE PROBLEM: Using common classroom/lab materials, design a vehicle which is driven by a propeller. The vehicle must be capable of travelling a distance 20' in the shortest possible time.

LIMITATIONS: The dimension limitations are:
- length - 12" max.
- height - 4" max.
- width - 4" max.
- prop. length - 6" max. (exception to height limitation)

Cost limitations:

TESTING PROCEDURE: Place the front of the car at starting point on the floor. The timer, who is standing at the finish line calls start. The student then activates the propeller. Three tries are allowed. The best score will then be calculated for the student's grade.

*/ stop watch is necessary

EVALUATION: +4 pts. for every foot vehicle travels
-1 pt. for every 5% reduction from best time
Total possible points = 80
Example - if best time: 5 sec. = 20 pts.
4.95 sec. = 19 pts.
4.50 sec. = 18 pts.

-5 pts. if it fails to meet height requirement
-5 pts. if it fails to meet length requirement
-5 pts. if it fails to meet width requirement
-5 pts. if it fails to meet cost requirement

BILL OF MATERIALS

Part No.	Name and Quantity	Description
1	Handlebars	Bicycle handlebars
2	Steering pivot	Front end of girl's 26 in. bicycle
3	Shut off switch	Toggle switch to engine ground
4	Brake	Hand formed mild steel shafting with handle grid
5	Frame	1½-2 in. steel tubing, (48 in.)
6	Shell	Plastic molded shell
7	Throttle	Lever and throttle cable
8	Seat	Molded plastic seat
9	Drive pulley	4 x ½ (Hole size fitted to engine crankshaft)
10	Tower support	3/4 in. thin wall conduit (EMT)
11	Belt guard	3/4 in. thin wall conduit (EMT)
12	Tower support	3/4 in. thin wall conduit (EMT)
13	V-Belt	½" V-belt
14	Prop guard frame	1/8 x ½ x ½ mild steel angle iron (octagon shaped, approx. 40 in. across flats)
15	Propeller	4 x 36, 16 gauge sheet steel, 4 in. radius on ends, pitch formed in slip rolls
16	Safety screen	Steel screen 3/6" in square mesh
17	Bearings	Sealed Bearings (3/4 in. to 1 in. spindle)
18	Prop guard support	1/8 x 1 x 1 mild steel angle iron
19	Prop guard support	1/8 x 1 x 1 mild steel angle iron
20	Prop hub	6 in. machined steel welded to spindle

Applied Math & Science Principles

Trigonometry principles

Gear reduction

Friction principles

Torque concept

Basic electrical principles

Laws of motion

Force principles

Social / Environmental Impact

Cutting the cost of operating an automobile in the past decade has been a concern of people throughout the world. The fact that petroleum prices appeared to control our world's economy had led man to look for alternative methods of power vehicles. Using air power on land is an often overlooked aspect of transportation. Could wind power and the gasoline engine make vehicles? More energy efficient? Is a giant rubber band propelled perpetual motion car the answer?

The question also arises: "can we do without massive oil consumption?" Oil producing countries owe banks in our country a tremendous amount of money.

Creative Problem Solving Activities

Design a vehicle which is "propelled by wind or air."

Design a steering system for a small vehicle powered by wind or air.

Determine an appropriate wheel base for a wind or air powered car. (least amount of friction.)

Design a mechanism for powering an air propelled vehicle.

Design a working scale model out of card-board wood and glue. The model is not to exceed 10".

Build a wind tunnel to help determine the most aerodynamically efficient body.

Related Careers

Metal Cutting Machine Operator

Machinist

Lathe Operator

Manufacturing Inspector and Painter

Mechanic

Mill Wright

Numerical Control Tool Operator and Programmer

Patternmaker and Mold Maker

Polisher and Buffer

Punch and Stamping Press Operator

Production Welder

Sheet Metal Worker

Drafter

Electrical and Electronic Engineer and Technician

Mechanical Engineer and Technician

Auto Body Repairer

References

Kupchella, Thomas; Gasoline Powered Ice Sled, School Shop, Jan. 1975 (pp. 38-9).

Mother Earth News Books - Drawing for Building a 3-Wheeled Vehicle

Activities for Teaching Technology

Activity Title MOUSEMOBILE

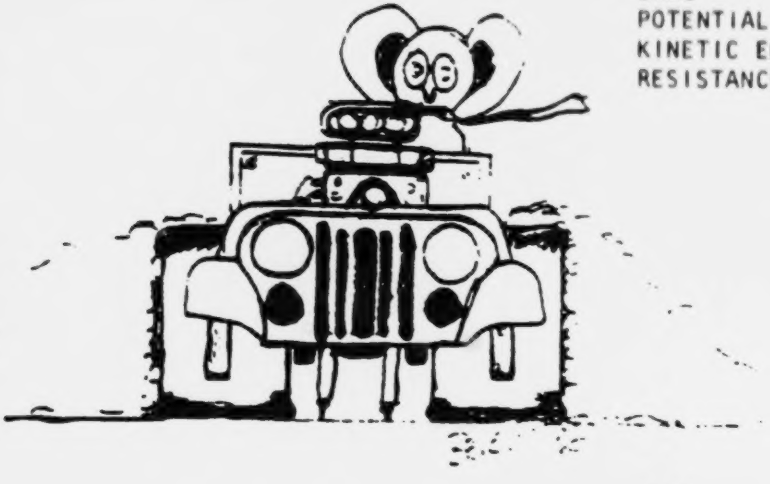
Contributor CHARLES H. MEDDAUGH

Time Required 5 HRS (1 WEEK)

Activity Description In this activity students will build a vehicle that is powered by a mousetrap. The vehicle may be made of any material or combination of materials and the design is left totally to the builder. The mousetrap's spring may not be altered in any way, although other alterations such as mounting holes or extensions to increase the length of throw are permissable. This activity includes applications of math, science, physics and problem solving.

Terms

INERTIA
ACCELERATE
DECELERATE
LEVERAGE
FRICTION
DRAG
POTENTIAL ENERGY
KINETIC ENERGY
RESISTANCE



Objectives

As a result of this activity the student will be able to:

write the definitions of the terms listed above.

figure the circumference of items of different diameters.

produce a working sketch.

identify each of the three classes of lever.

solve ten leverage problems with eighty-five percent accuracy.

calculate the size of each component in his/her driveline mathematically.

construct a graph comparing the coast and strength of each girder he/she constructed.

Special Supplies & Equipment | Supplier

1. Victor mousetraps
2. PFS:GRAPH software (optional)
3. Data base software (optional)
4. Computer (optional)

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Student Handouts

THE MOUSEMOBILE

No a mousemobile is not a car driven by Mickey, rather it is a racing vehicle that is powered by a mousetrap. The mousetrap may be the only source of power for the vehicle, but inertia may help carry it to the finish point. The spring on the trap may not be altered or rewound, but levers, gears, pullies, etc. may be attached to it. Power is transferred from the trap to the vehicle's axle through a string. Sufficient string must be used to allow the vehicle to reach the finish point exactly twenty feet from the starting point. A starting and finishing "point" must be used because a mousemobile is raced for accuracy as well as speed.

The racecourse is a starting point and a finish point, on a flat surface, twenty feet apart. The race is scored by first taking the vehicle's elapsed time and then measuring the distance from the finishing point to the midpoint of the front of the vehicle. One tenth of a second is added to the time for each 1/4 inch that the car is off course.

Before you start construction of your mousemobile you must work out the details of its driveline. Several factors must be considered such as wheel and axle size, and how to get both acceleration and speed. Several possibilities will be discussed in class to help you decide which approach to take.

name ______________________________

2. dia. wheel? _______
cir. wheel? _______
dia. axle? _______
cir. axle? _______
rev. of wheel
per 20'? _______
string lg.? _______
extension ? _______

3.

4.

MOUSEMOBILE CONSTRUCTION

EQUIPMENT/SUPPLIES

The equipment and supplies needed will vary according to the type of lab materials chosen for the mousemobile.

PROCEDURE:

1. In field one on the handout provided, sketch your mousemobile design.
2. Fill in field number two of the handout with the dimensions required. Show all of your calculations in field four of the handout.
3. In field three of the handout produce a bill of material for your mousemobile.
4. Have your calculations checked by our instructor before cutting any material.
5. On a separate sheet of paper make a working drawing of your mousemobile. Be sure to include dimensions.
6. Have your drawing checked by your instructor.
7. Develop a step by step construction plan for the assembly of your mousemobile.
8. Have your plan checked by the instructor.
9. Gather all of the materials needed for the assembly of your mousemobile.
10. Assemble your mousemobile following the steps developed on your construction plan.
11. Test your mousemobile for speed and accuracy.
12. Make any changes you feel necessary to improve your design.
13. Turn the finished product in to the instructor for grading.

Definition of Terms

INERTIA: The tendency of all objects and matter in the universe to stay still if still, or, if moving to go on moving.

ACCELERATE: A change in velocity. (physics) An increase in velocity is a positive acceleration.

DECELERATE: To decrease in velocity. (physics) Negative acceleration.

FRICTION: Resistance to motion of two surfaces that touch. Resistance of a body in motion to air.

DRAG: The force acting on a body in motion through a fluid (air) in a direction opposite to the body's motion produced by friction.

RESISTANCE: A opposing force, especially one tending to prevent motion.

LEVERAGE: The advantage of power gained by using a lever.

Applied Math & Science Principles

MATH:

area　circumference　ratios

SCIENCE:

conservation of energy　simple machines

Social/Environmental Impact

The use of small energy efficient power supplies is becoming more prevalent every day. This activity is designed to increase the student's awareness of efficient use of energy and power.

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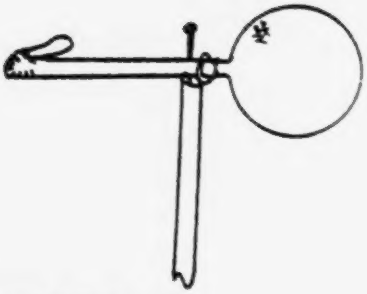
Activities for Teaching Technology

Activity Title	BUILD YOUR OWN AIRCRAFT
Contributor	ED BALL
Time Required	3 WEEKS (15 DAYS)
Activity Description	There are aircrafts of many types in today's area of transportation. In this activity the student will research three areas of aircraft: balloon/blimp, airplane/jet, rocket/spacecraft. Following this they will construct an aircraft that will be judged on looks, flyability, landing, accuracy, and time spent on developing it.

Terms

AIRCRAFT
AIRFOIL
AIRPLANE
BALLOON
BERNOULLI'S PRINCIPLE
BLIMP
DRAG
JET
ROCKET
SPACECRAFT



JET STRAW

Objectives

To gain understanding of problem solving techniques through research, and through construction of an aircraft.

To excercise research and development skills.

To construct a working model of an aircraft.

To become aware of the many areas of air and space transportation technology.

To become aware of the social impact air/space transportation has on our society.

Special Supplies & Equipment	Supplier
1. Miscellaneous: straws, tubes, file folders, paper styrofoam, etc.	

Transparency Masters
&
Student Handouts

AIRCRAFT ACTIVITY

MATERIALS:

1. Miscellaneous: paper, pipecleaners, styrofoam, Balsa wood, etc.
2. Glue, tape
3. Scissors, blades
4. String, etc.

All students are required to make one aircraft. They are not to make any purchases toward this aircraft unless they themselves want to. A regular aircraft kit (airplane,glider, etc.) is not allowed and constitutes a failing mark.

RULES:

1. All aircrafts must be made of (3) or more different materials (ex: paper, tape, glue, metal, wood, cardboard, etc.)

   -Two different types (not colors) of paper count as two separate materials.

2. All work must be done in class!

   - Can get ideas outside of class but no work.
   - Can bring in extra materials and equipment.

3. A plan or drawing must be submitted.

4. Must be able to fly! (Not like a rock.)

5. Must be no longer than 16" and no higher than 8".

   - Wing span has no limit!

6. Must fly accurately!

   - Must land in designated area.
   - Close to a given target.

7. Must look good!

   - Look like an aircraft.
   - Neat.

SUGGESTED JUDGING AND GRADES

1.	LOOKS: shape, neatness, etc.	20 pts.
2.	FLYABILITY: technology used, flight length, etc.	20 pts.
3.	LANDING: smooth, crash, belly up, etc.	15 pts.
4.	ACCURACY: straight, hook or slice, etc.	15 pts.
5.	TIME: time spent involved with project.	30 pts.
	TOTAL POSSIBLE:	100 pts.

*NOTE: Higher points are given for areas where students have more control. Points for problem solving are lower so not to affect academic performance, but to strive to overcome these obstacles.

* ALL JUDGING DONE OVER A PERIOD OF 3 FLIGHTS.

Definition of Terms

AIRCRAFT: Weight-carrying structure that can travel through the air, supported either by its own buoyancy or by dynamic action of the air against its surfaces.

AIRFOIL: A shape which causes an upward force as air flows over the shape.

AIRPLANE: Heavier-than-air craft that is propelled mechanically and supported by the dynamic action of the air stream on fixed-wing surfaces. Gliders, helicopters, etc. fall into this category.

BALLOON: A bag made of varnished silk, rubber, or other suitable material, containing a gas that is lighter than air.

BERNOULLI'S PRINCIPLE: Air pressure is indirectly proportional to its velocity over a surface.

BLIMP: Lighter-than-air craft equipped with a bag containing a gas to lift the ship, a way to propel, a means for buoyancy, and one or more special areas for the crew, passengers, and power units.

DRAG: Air resistance on a moving object.

JET: (JET PROPULSION) Thrust forcing forward motion to an object as a reaction to the rearward explusion of a high-velocity liquid or gas stream.

ROCKET: General term for a jet propulsion device propelled by the explusion of gases generated in a combusion chamber.

SPACECRAFT: Any craft engineered for the purpose of space travel and exploration (manned or unmanned).

Applied Math & Science Principles

STUDY:

1. Laws of Gravity
2. Laws of Motion
3. Why does a satellite stay up?
4. Bernoulli's Principle

Social/Environmental Impact

1. Discuss social and economical impact of air technology today.
2. What impact does safety or lack of it play in the area of research and development of aircraft?

   - Does it affect social areas? How?
   - Does it affect economic areas? How?
   - Does it affect other areas? Which? How?

3. Which aircrafts are for: recreation purposes? economical purposes? military? commercial? etc.

Creative Problem Solving Activities

1. Have a contest to see whose craft can:
   - fly the longest (flight duration)
   - fly the farthest

2. Set up a hoop and make everyone fly their aircraft through. Most will have to re-engineer their craft to work.

3. Set the aircraft on a balance scale. Place a fan in front and turn it on low. Zero the scale with the plane on it. It should rise up with the air flowing over its wings.

Related Careers

Air Traffic Controller

Pilots

Mechanics

Baggage Handlers

Flight Attendants

Astronaut

Communications Engineer

Technician

Fuel Specialist

Trainer/Teacher

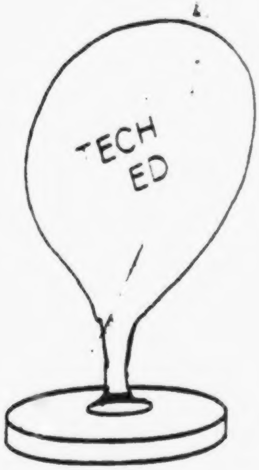
References

Activities for Teaching Technology

Activity Title	CONSTRUCTING AN AIR CUSHION VEHICLE
Contributor	ED BALL
Time Required	3 to 5 DAYS
Activity Description	There are vehicles made today that travel on a cushion of air. Students will construct a vehicle of their own to help understand how an air vehicle basically operates.

Terms

FORCE
WEIGHT
FRICTION
MOTION
NEWTON'S LAWS OF MOTION
ACCELERATION
ENERGY
VELOCITY



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Objectives

To gain the understanding of the basic principles of air cushion flight.

To construct a simple air-float vehicle.

Special Supplies & Equipment

1. 1/8" hardboard
2. 3/4" dowel rod
3. Balloon (good quality and approximately 10" in diam.)
4. Polyvinyl glue

Supplier

Transparency Masters
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Student Handouts

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AIR CUSHION VEHICLE

MATERIALS:

1. 1/8 x 3" dia. hardboard
2. 3/4 x 1" dowel rod
3. Hot glue (if possible)
4. "C" clamp
5. Countersink bit
6. 10" party balloon

A. CONSTRUCTION PROCEDURES:

Follow these steps to construct your air cushion vehicle:

1. Gather all the necessary equipment and supplies.

2. Using a compass, lay out a 3" diameter circle on the hardboard. Clearly mark the center of the circle.

3. Using a coping saw, jig saw, or band saw, saw around the circle to form a disc.

4. Cut a piece of dowel rod 1" long.

5. Glue one end of the dowel rod in the EXACT center of the disc. Clamp the dowel rod to the disc until the glue dries and the dowel is secure.

6. Drill a 1/8" hole through the center of the dowel and disc (see drawing.)

B. TESTING PROCEDURES:

Follow these steps to test your air cushioned vehicle:

1. Prepare the testing area.

2. Place the neck of the balloon over the wooden dowel.

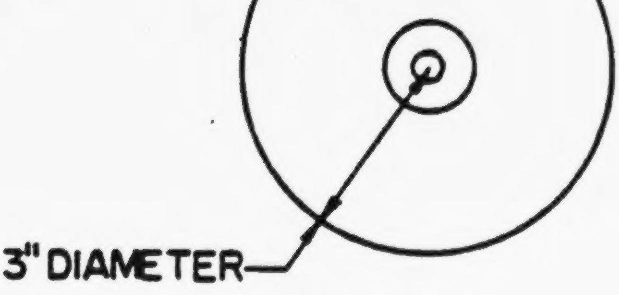
3. Inflate the balloon by blowing through the counter sunk hole in the disc.

4. Hold your finger over the hole, so the balloon will not loose air, and move to the testing area. (Table 4' x 4')

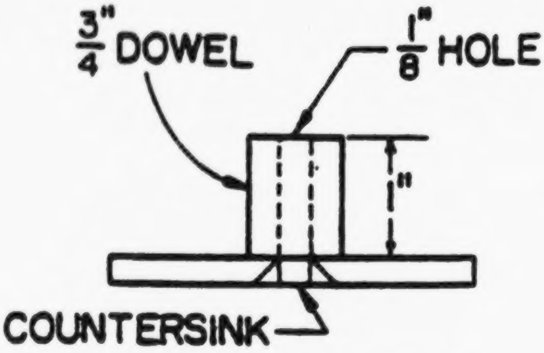
5. Set the air cushioned vehicle upright and give it a slight push. The vehicle should move around the test area.

6. Make design changes to the vehicle as needed:
   a. More air in balloon.
   b. Larger hole or counter sink.
   c. Larger balloon.
   d. Or other changes.

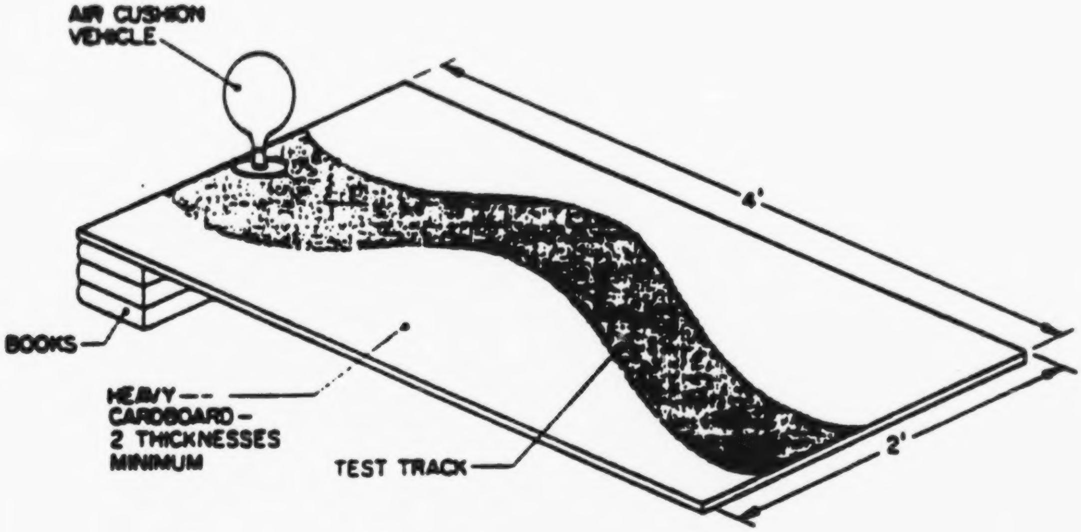
7. Describe any changes you made and tell why you made them. Note them on paper.



A. Disc.


$\frac{3}{4}$" DOWEL
$\frac{1}{8}$" HOLE
1"
COUNTERSINK

B. Disc-dowel assembly.


AIR CUSHION VEHICLE
4'
BOOKS
HEAVY CARDBOARD - 2 THICKNESSES MINIMUM
TEST TRACK
2'

Definition of Terms

ACCELERATION: The increase of velocity every second measured in metrics per second per second, (m/s^2).

ENERGY: A measure of the capacity to do work, measured in joules (J).

FORCE: Any action that alters a body's state of rest or of uniform motion in a straight line. Measured in newtons (N).

FRICTION: A force that occurs whenever two things rub together.

MOTION: The act or process of moving, movement.

NEWTON'S LAWS OF MOTION:

1. Every body remains in a state of rest or uniform motion in in a straight line unless acted upon by forces from the outside.

2. The amount of acceleration of a body is proportional to the acting force and inversely proportional to the mass of the body.

3. Every action has an equal and opposite reaction.

VELOCITY: The speed of a body in a particular direction measured in meters per second (m/s).

WEIGHT: The force exerted on matter by the gravitational pull of the earth, measured in newtons (N)

Applied Math & Science Principles

All three Newton's, Laws of Motion.

The figuring of the vehicle's speed.

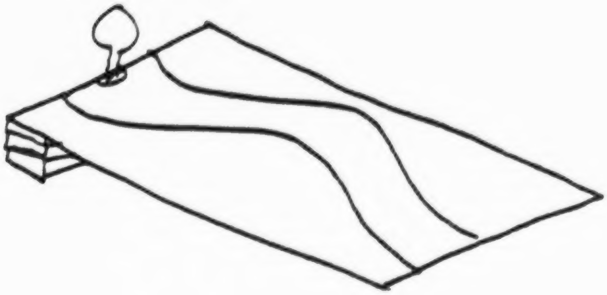
Social/Environmental Impact

1. With today's energy picture, discuss how air vehicles play an important role and discuss the pros and cons.
2. If society accepted and produced more air cushioned vehicles, how might that affect the economy balance as we see it today.
3. Where are other areas of transportation that air cushioning may benefit?

Creative Problem Solving Activities

1. Make a testing area table. Use a 1/8" x 2' x 4' sheet of hard board for the surface. Place a bordering fence 2½ to 3" all the way around to keep air cushioned vehicles on testing surface.

2. Make a test track for experimenting or racing.
   a. Make the test track sides parallel and at least 8" apart.
   b. Increase "bank" sides of vehicles. Don't stay within the test track.
   c. Figure out the speed of your vehicle.



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Related Careers

Researcher

Engineer

Air Transportation Specialist

Pilots

Mechanics (Air Vehicle)

Technologist

References

Energy, Power, and Transportation. Bohn, McDonald and Fales, Kuetemeyer; Bennett and McKnight, 1986.

CONSTRUCTION

Activities for Teaching Technology

Activity Title SPACE SHUTTLE CONSTRUCTION

Contributor CHARLES GOSDZINSKI

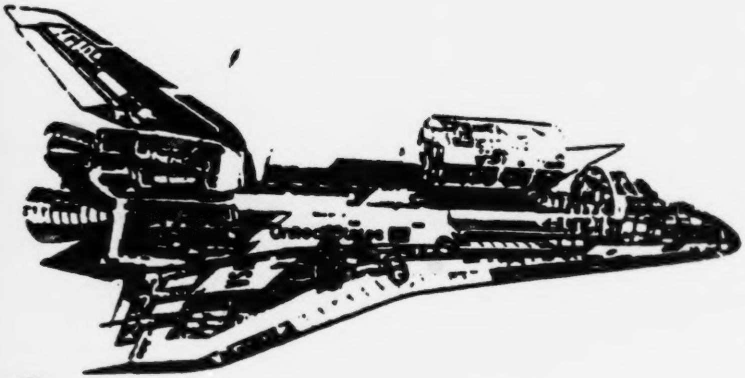
Time Required MIN. 5 TO 9 WKS

Activity Description

The activity involves the construction of a scale model of the Space Shuttle. The model will be developed through use of a scale model or drawing. The skill of the class will determine its sophistication. Its length could be anywhere from 1-20 feet. A portion or all of the Shuttle would be developed. The most desirable situation is to have the model of the Shuttle large enough to place a computer in the cockpit area. The computer would then be used to run a Space Shuttle or flight simulation program.

Terms

AFT FLIGHT DECK
AIRLOCK
CARGO BAY
COMMANDER
EXTERNAL TANK
FLIGHT CONTROL TEAM
FLIGHT DATA FILE
FLIGHT PHASES
INCLINATION
INTACT ABORT
INERTIAL UPPER STAGE
LONG DURATION EXPOSURE FACILITY
MANNED MANEUVERING UNIT
MISSION CONTROL CENTER
MISSION SPECIALIST
ORBITAL MANEUVERING SUBSYSTEM
ORBITOR
PAYLOAD SPECIALISTS
PILOT
REACTION CONTROL SUBSYSTEM
RETRIEVAL
SOLID ROCKET BOOSTER
SPACELAB
SPACE SHUTTLE VEHICLE
TIT/SPIN TABLE



Objectives

As a result of their learning experience:

Students will understand the concept of scaling.

Students will be able to determine the most suitable materials for model construction.

Students will be able to boot and run a micro-processor program.

Students will be able to identify the various principles of flight.

Students will be able to identify and describe the various components of the Space Shuttle Vehicle.

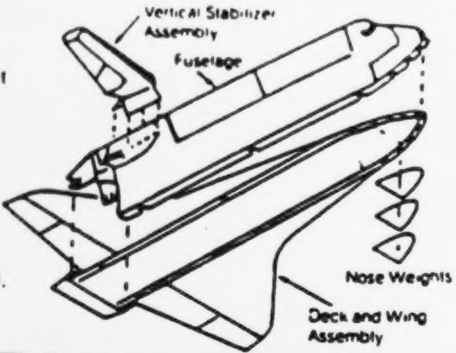
Special Supplies & Equipment	Supplier
1. Cardboard (most desirable - least expensive)	
2. Duct tape - packaging tape	
3. 3/4 x 3/4 pine strips	
4. Staple gun with H.D. staples	
5. Scissors - Utility knife	
6. Straight edge	
7. Finishing nails	
8. Hammer	
9. Handsaw	
10. Apple IIE computer	
11. Computer program "RENDEZVOUS" (simulates an actual space shuttle flight from Earth Lift; through Orbital Rendezvous and Approach, to Alignment and Docking with a space station.)	TRANS 2
12. Computer program "FLIGHT SIMULATOR II." (computer simulation provides a safe context for learning skills actually used by pilots in the air; and some of the basics of flight technology.)	TRANS 2

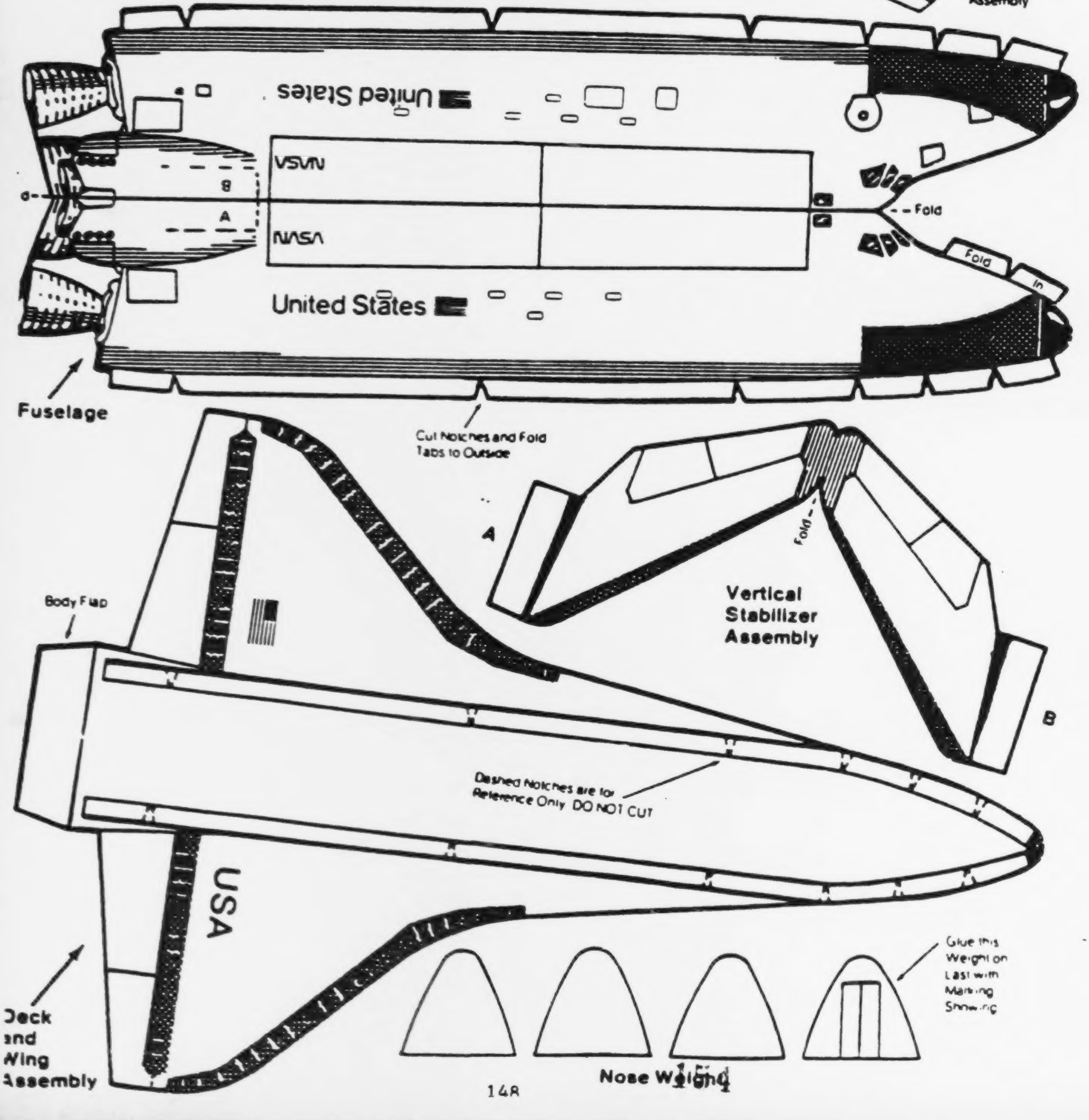
Transparency Masters
&
Student Handouts

Assembly Instructions: Read carefully before assembly

1. Cut out all parts using scissors
2. Cut out V-shaped notches on Fuselage to create tabs along outside edge. Fold tabs out
3. Glue or tape three Nose Weights to underside of nose of your glider. Use the fourth weight provided if needed for extra trim after assembly.
4. Fold Fuselage along middle line.
5. Starting at the nose, glue or tape fuselage to Deck and Wing Assembly. Match tabs on Fuselage exactly to those printed on Deck and Wing Assembly.
6. To close the nose, glue or tape the two halves together using tabs provided.
7. Fold Vertical Stabilizer Assembly. Fold out tabs A and B. Except for tabs A and B, glue or tape Vertical Stabilizer Assembly to make one solid piece.
8. Attach Vertical Stabilizer to Fuselage, matching tab A with point A and tab B with point B.

Preflight Instructions: For best results, launch your Shuttle glider with a gentle, *level* toss. Bend the Body Flap up slightly for greater lift.

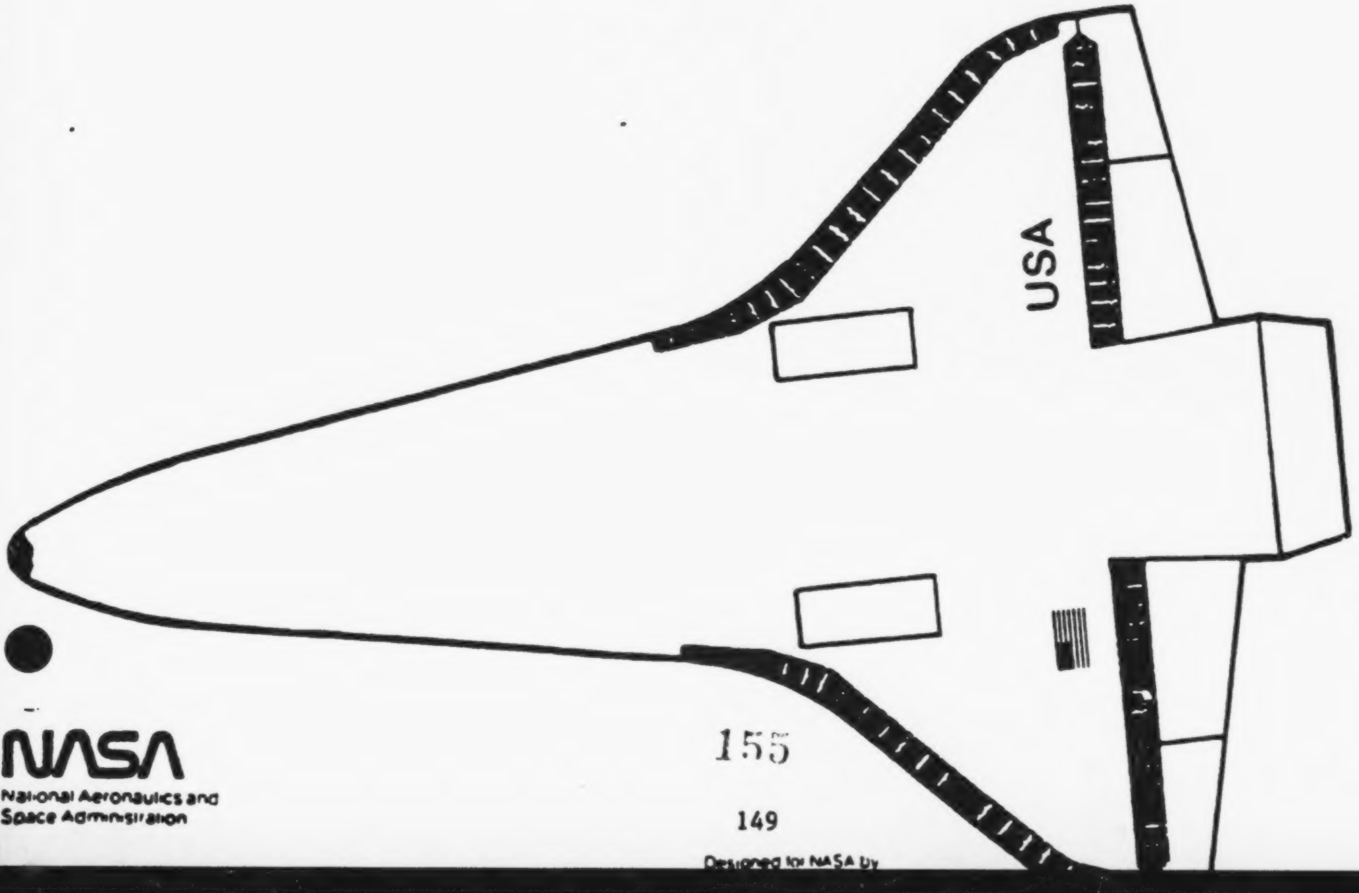

Vertical Stabilizer Assembly
Fuselage
Nose Weights
Deck and Wing Assembly


United States
NASA
NASA
United States
B
A
Fold
Fold
In
Fuselage
Cut Notches and Fold Tabs to Outside
A
Fold
Vertical Stabilizer Assembly
B
Body Flap
Dashed Notches are for Reference Only DO NOT CUT
USA
Deck and Wing Assembly
Glue this Weight on Last with Marking Showing
Nose Weight

U. S. Space Shuttle Glider Kit

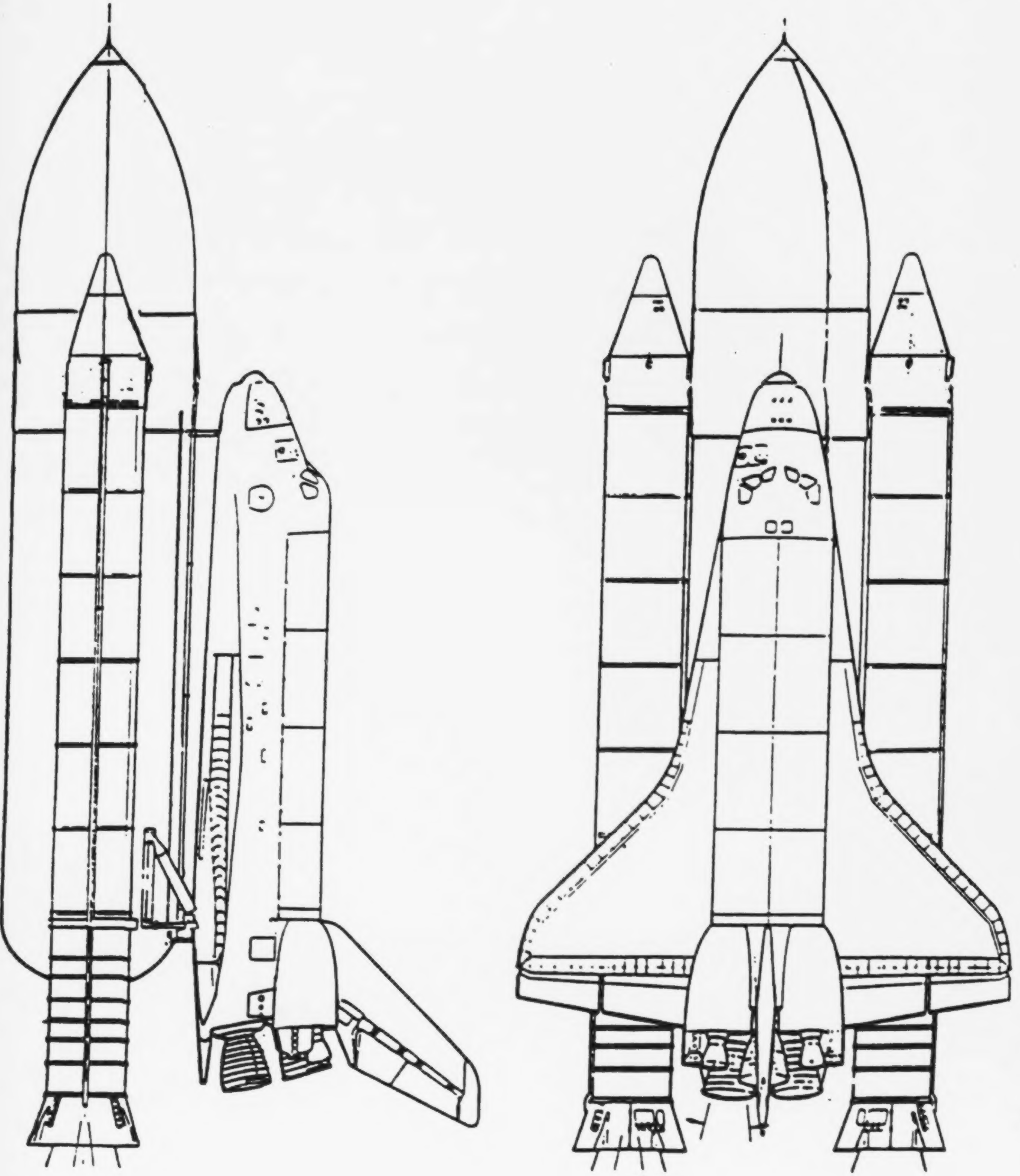
r Space Shuttle glider is a 1:200-scale model of the U.S. Space Shuttle Orbiter. The airplane-like Orbiter will function as a space station which can remain in Earth orbit for up to 30 days at a time. It will normally carry about seven people; three of these will be astronaut-pilots, the others will be specialists in some area of science or technology. From the space-station Orbiter, the crew will be able to conduct many of the space missions which until now have been executed from Earth; they will be able to launch satellites (weather, communications, navigation, Earth Resources), scientific spacecraft (to explore and study our solar system), and military spacecraft. In addition, the crew will be able to retrieve and repair satellites and to conduct onboard experiments. At the end of each mission, the 120-ft. Orbiter will be piloted back to Earth and land, like an airplane, on an airstrip. It will then be refurbished so that in two weeks it is ready for another mission. In this manner, each Orbiter is expected to be used at least 100 times.

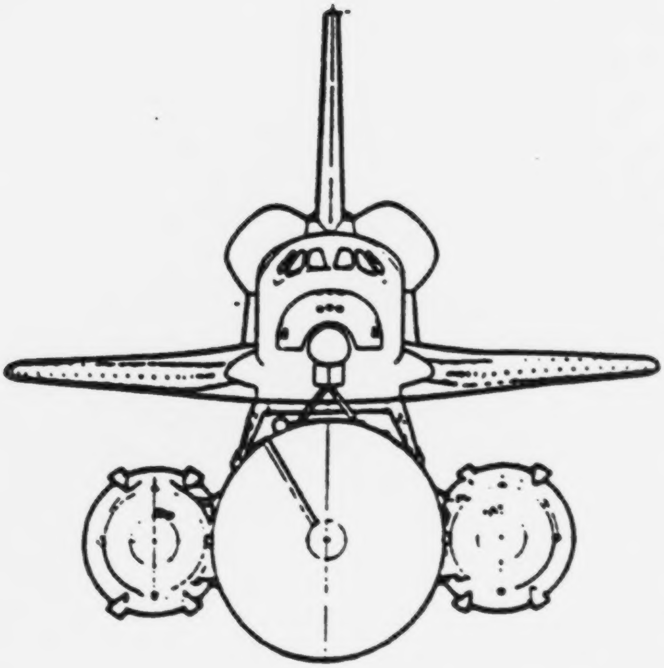
The orbiter and its engines are just part of the Space Shuttle system. The other parts are the solid rocket boosters (SRB's) used for launch and the external tank that contains liquid propellant for the engines. All of these parts are reusable except the tank, which is jettisoned just before the Shuttle Orbiter achieves Earth orbit. This ability to reuse costly equipment, as well as the ability to conduct missions from Earth orbit, will substantially decrease the cost of space operations. Just as during our Earth-bound years we relied upon trucks, trains, and airlines to provide transportation, so during the coming years we will rely upon the Space Shuttle to provide transportation to and from space.

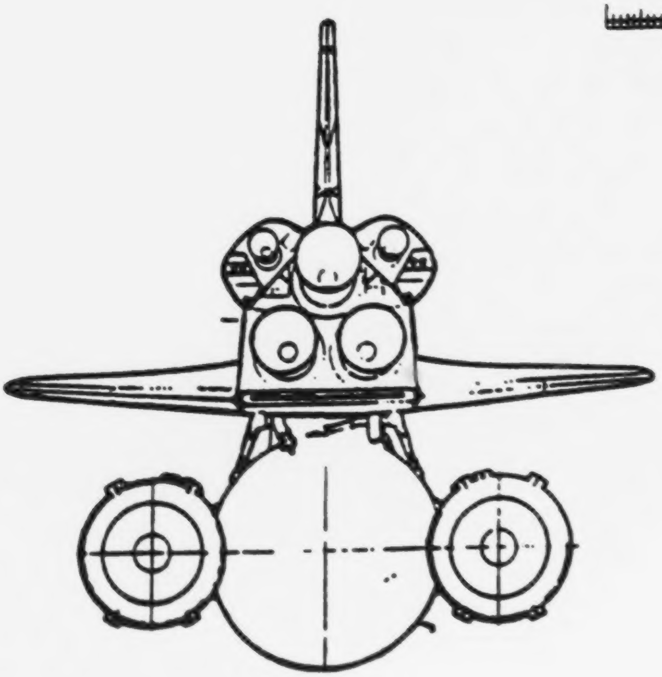


National Aeronautics and
Space Administration

Designed for NASA by





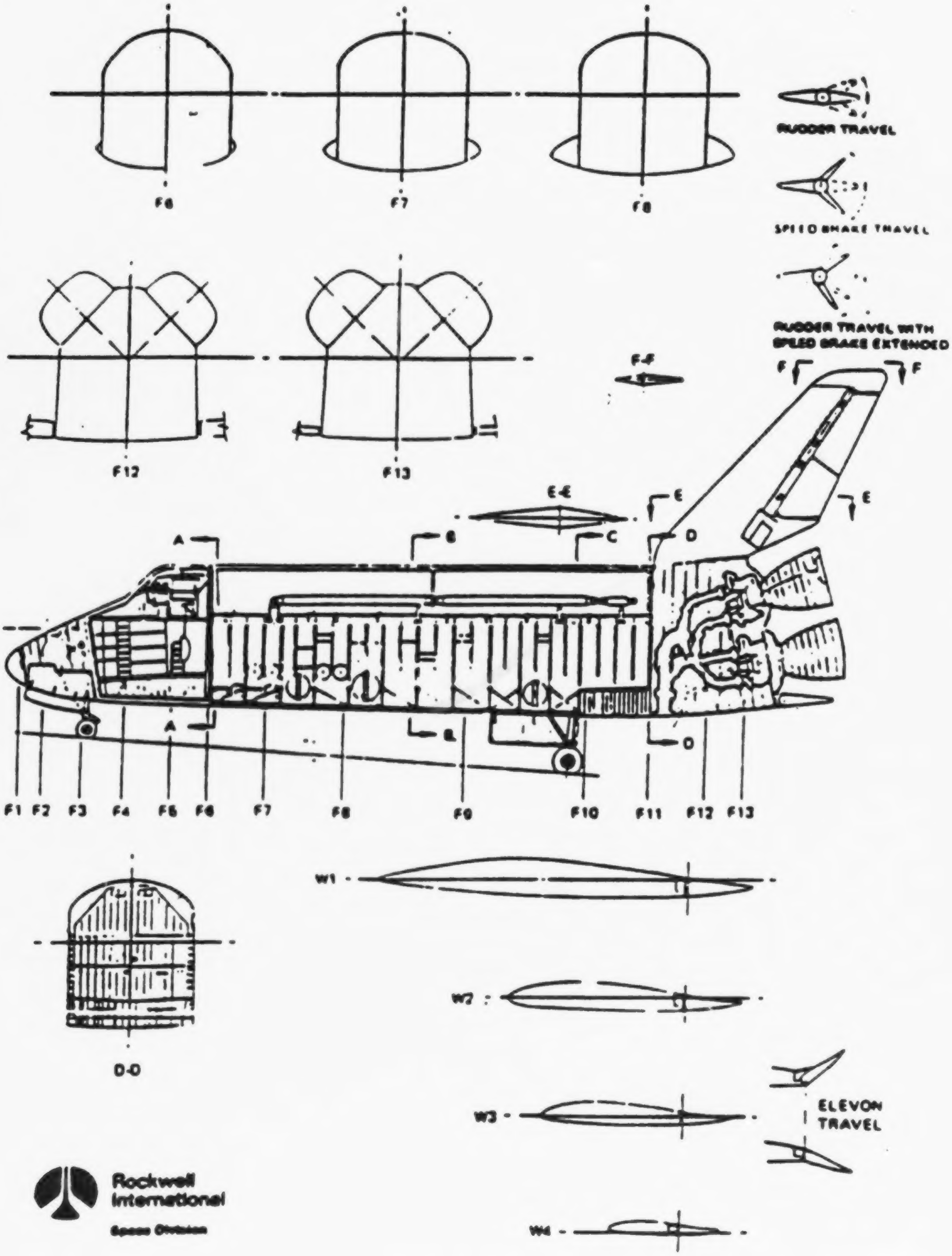


1/200TH SCALE

REVISED 7/76

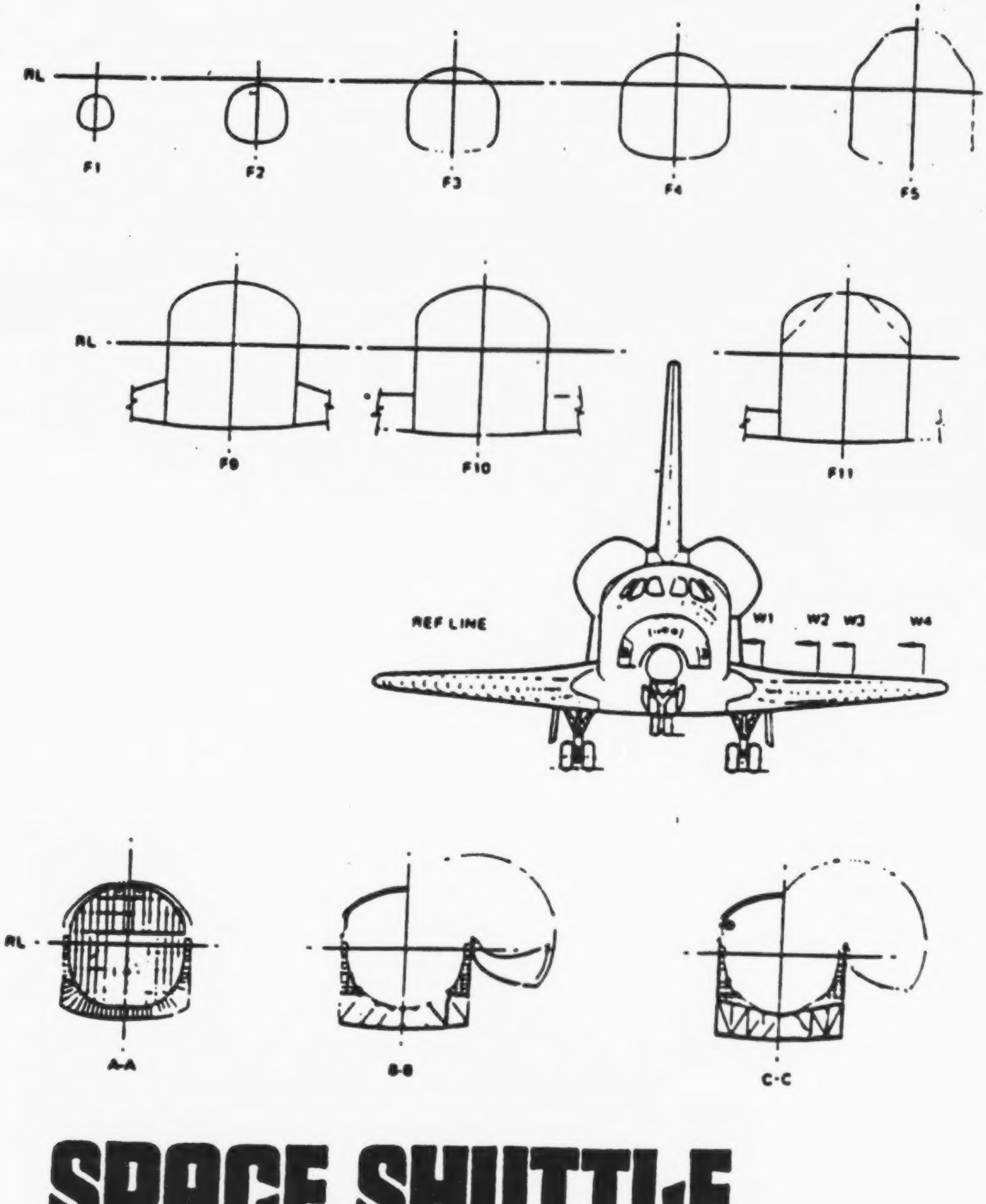
0
100
200
300
400
500
INCHES
0
200
400
600
800
1000
CENTIMETERS

Based On Engineering Drawings
By Dustin W. Carter


F6
F7
F8
RUDDER TRAVEL
SPEED BRAKE TRAVEL
RUDDER TRAVEL WITH SPEED BRAKE EXTENDED
F12
F13
F-F
F
F
E-E
E
E
A
B
C
D
A
B
D
F1
F2
F3
F4
F5
F6
F7
F8
F9
F10
F11
F12
F13
W1
D-D
W2
W3
ELEVON TRAVEL
W4

Rockwell International

Space Division


RL
F1
F2
F3
F4
F5
RL
F9
F10
F11
REF LINE
W1
W2
W3
W4
RL
A-A
B-B
C-C

SPACE SHUTTLE

SHUTTLE CHARACTERISTIC
(values are approximate)

LENGTH
System: 56.14 m (184.2 feet)
Orbiter: 37.24 m (122.2 feet)

HEIGHT
System: 23.34 m (76.6 feet)
Orbiter: 17.27 m (56.67 feet)

WINGSPAN
Orbiter: 23.79 m (78.06 feet)

WEIGHT
Gross Lift-Off:
1,995,840 kg (4.4 million pounds)
Orbiter Landing:
84,778 kg (187 thousand pounds)

THRUST
Solid-Rocket Boosters (2):
12,899,200 newtons (2.9 million pounds) of thrust each at sea level

Orbiter Main Engines (3):
1,668,000 newtons (375 thousand pounds) of thrust each at sea level

CARGO BAY
Dimensions:
18.28 m (60 feet) long, 4.57 m (16 feet) in diameter

Accommodations:
Unmanned spacecraft to fully equipped scientific labs

Definition of Terms

AFT FLIGHT DECK: That part of the Orbiter cabin on the upper deck where payload controls are located.

AIRLOCK: A compartment, capable of being depressurized without depressurization of the Orbiter cabin, used to transfer crewmembers and equipment.

CARGO BAY: The unpressurized mid-part of the Orbiter fuselage behind the crew cabin where payloads are carried. Its maximum usable envelope is 15 feet in diameter and 60 feet long. Hinged doors extend the full length of the bay.

COMMANDER: This crewmember has ultimate responsibility for the safety of embarked personnel and has authority throughout the flight to deviate from the flight plan, procedures, and crew assignments as necessary to preserve human safety or vehicle integrity. The commander is also responsible for the overall execution of the flight plan.

EXTERNAL TANK: Element of the Space Shuttle system that contains liquid propellants for the Orbiter main engines. It is jettisoned prior to orbit insertion.

FLIGHT CONTROL TEAM: A group of ground controllers at the Mission Control Center on duty to provide real-time support for the duration of each Shuttle flight.

FLIGHT PHASES: Prelaunch, launch, in orbit, deorbit, entry, landing, and postlanding.

INCLINATION: The angle between the orbit plane and the equatorial plane. It corresponds to the highest latitude over which a satellite passes.

INTACT ABORT: Any of three abort modes which are designed to bring the Orbiter and crew back to a safe landing.

INERTIAL UPPER STAGE: Solid propulsive upper stage designed to place spacecraft in high Earth and retrieved by the Remote Manipulator System.

LONG DURATION EXPOSURE FACILITY: Free-flying reusable satellite designed primarily for small passive or self-contained active experiments that require prolonged exposure to space. It is launched in the Orbiter cargo bay and deployed and retrieved by the Remote Manipulator System.

MANNED MANEUVERING UNIT: A propulsive backpack device for maneuvering during extravehicular activities. It uses a low-thrust, dry, cold nitrogen propellant.

MISSION CONTROL CENTER: Central area at the Johnson Space Center for control and support of all phases of Shuttle flights.

Definition of Terms

MISSION SPECIALIST: This crewmember is responsible for coordination of all payload operations and directs the allocation of resources to accomplish mission objectives. The mission specialist will have prime responsibility for experiments to which no Payload Specialist is assigned, and will assist a Payload Specialist when appropriate.

ORBITAL MANEUVERING SUBSYSTEM: Orbiter engines that provide the thrust to perform orbit insertion, circularization, or transfer, rendezvous, and deorbit.

ORBITER: Manned orbital flight vehicle of the Space Shuttle System.

PAYLOAD SPECIALIST: This crewmember, who may or may not be a career astronaut, is responsible for the operation and management of the experiments or other payload elements that are assigned to him or her, and for the achievement of their objectives. The payload specialist will be an expert in experiment design and operation.

PILOT: This crewmember is second in command of the flight and assists the commander as required in the conduct of all phases of Orbiter flight.

REACTION CONTROL SUBSYSTEM: Thrusters on the Orbiter that provide attitude control and three-axis translation during orbit insertion, on-orbit, and reentry phases of flight.

REMOTE MANIPULATOR SYSTEM: Mechanical arm on the cargo bay longeron. It is controlled from the Orbiter aft flight deck to deploy, retrieve, or move payloads.

RETRIEVAL: The process of utilizing the Remote Manipulator System and/or other handling aids to return a captured payload to a stowed or berthed position. No payload is considered retrieved until it is fully stowed for safe return or berthed for repair and maintenance tasks.

SOLID ROCKET BOOSTER: Element of the Space Shuttle that consists of two solid rocket motors to augment ascent thrust at launch. They are separated from the Orbiter soon after lift-off and recovered for reuse.

SPACELAB: A general-purpose orbiting laboratory for manned and automated activities in near-Earth orbit. It includes both module and pallet sections, which can be used separately or in several combinations.

SPACE SHUTTLE VEHICLE: Orbiter, External Tank, and two Solid Rocket Boosters.

TILT/SPIN TABLE: Mechanism installed in Orbiter cargo bay that deploys the spinning solid upper stage with its spacecraft.

Applied Math & Science Principles

Transposing dimensions through scaling concept.

Basic principles of flight.

Basic math, algebra, trignometric skills are reinforced.

Principles of forces (e.g. acceleration, centripetal, etc.)

Speed calculations.

Distance calculations.

Social / Environmental Impact

DIRECT BENEFITS

communication
medicine
meteorology
national security
natural resource development
  and exploration
navigation
scientific research
others

INDIRECT BENEFITS

improved trade balances
increased productivity
growth of national economy
lower inflation rates

Creative Problem Solving Activities

Allow students to determine the most suitable materials for construction. Have them take into consideration: materials available, cost, ease of construction, time of construction, and size.

Related Careers

Air Traffic Controller

Mathematician

Numerical Controller Programmer and Operator

Flight Engineer

Pilot

Electrical and Electronics Technician and Engineer

Manufacturing Technician and Engineer

Metal Cutting Machine Operator

Boring Machine and Drill Press Operator

Machinist

Manufacturing Inspector

Milling and Planing Machine Operator

Moldmaker and Coremaker

Lathe Operator

Millwright

Patternmaker and Model Maker

Polisher and Buffer

Tool and Die Maker

Production Welder

Robotics Technician

Heavy Equipment Operator

Industrial Designer

Miner

Crane Derrick and Hoist Operator

Sheet Metal Worker

Chemical Engineer and Technician

Drafter

Civil Engineer

Mechanical Engineer and Technician

Computer Technician

Physician

References

Kaplan, Marshall H., Space Shuttle, Aero Publishers, 1978.

NASA Lewis Research Center
Office of Educational Service
21000 Brook Park Rd.
Cleveland, OH 44135

Activities for Teaching Technology

Activity Title BRIDGE BUILDING

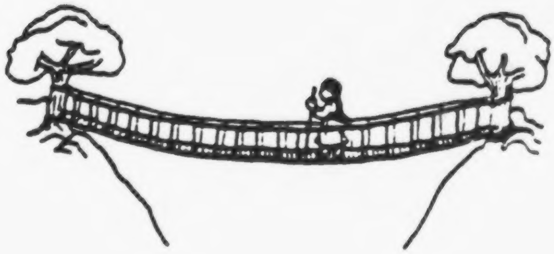
Contributor J. RUDNICK

Time Required 2 WEEKS (10 DAYS)

Activity Description This activity involves the construction of a bridge using 1/8" x 1/8" balsa wood. Other than the predetermined specifications on span and width, students may apply whatever design they feel will make the strongest, most efficient structure. Once completed, the bridge is tested for strength and a "failure weight" is determined.

Terms

ABUTMENTS
ARCH BRIDGE
BEAM BRIDGE
SPAN
SUSPENSION BRIDGE
TRUSS BRIDGE



Objectives

1. Students will understand and be able to apply a basic knowledge of bridge building.
2. Students will become aware and appreciate the social impact bridges have on society.
3. Students will learn of the history of bridges.

Special Supplies & Equipment	Supplier
1/8" x 1/8" balsa wood	
wax paper	
test block	
test hook	
5 gallon plastic pail	
sand	
balance scale	
calculator	

Transparency Masters
&
Student Handouts

Steps for Designing, Constructing, and Testing a Bridge

1. Using ¼" grid paper, students must draw a side view of the bridge they plan to build.

2. Once approved by the instructor, the students will fasten their drawing to the fiberboard and cover it with wax paper.

3. Using a single edge razor blade, the students cut the balsa as necessary and glue and pin it right over their drawing. (The wax paper prevents the structure from sticking.)

4. Once the side supports are completed, the cross members are cut and glued. Minimum and maximum span and width dimensions must be adhered to.

5. Once the 18 hour drying time has passed, the bridge is weighed, and the weight recorded.

6. The bridge is then loaded onto the test block and the testing hook installed.

7. The 5 gallon pail is hung from the hook and sand is slowly poured in until the bridge fails.

8. The failure weight is then determined by weighing the pail. Efficiency is then determined by dividing the failure weight by the bridge weight.

THE BRIDGE BUILDING CONTEST

OVERVIEW: Teams made up of two members each will construct a model bridge (truss system). The bridge is then destructively tested to determine the efficiency of the student's design.

I. CONTEST PURPOSE

The purpose of the Bridge Building contest is to provide a means for team members to demonstrate their ability to fabricate a truss bridge after having been assigned length and width specifications.

II. TIME LIMITATIONS

The allotted time for design and construction of the bridge will be 3 hours, or three class periods.

III. SPECIFIC REGULATIONS

A. There shall be no more than two (2) members per team.

B. All work must be done in the classroom.

C. A full scale side view drawing of the bridge must be done using the ¼" grid paper prior to the beginning of construction.

D. The specifications for the span and width of the bridge are:

Span	8" minimum
	18" maximum
Width	2.5" minimum
	5" maximum

E. Bridges must be constructed in such a manner as to accommodate the test hook (see diagram BB-1) at the bridge's center. The road bed of the bridge must be free of obstructions. The bridge must be constructed to allow the test block (without the hook) to pass from one end to the other.

F. Bridges will be allowed to dry a minimum of 18 hours. Bridges will then be tested by applying weight until they fail.

G. Parallel members of the bridge may be glued surface to surface as long as the glue does not cover more than ¼" for each 2" of overlap.

IV. REQUIRED MATERIALS AND SUPPLIES

1. Construction materials
    a. White glue
    b. Balsa 1/8" x 1/8"

2. Construction tools
    a. Grid paper, ¼" squares, 8' ½" x 11' or 8' ½" x 18'
    b. Fiberboard, ½" x 12" x 12"

    c. Cutting board, 3/4" x 12" x 12"
    d. Single edge razor blade
    e. Straight pins
    f. Ruler, 12"
    g. Wax paper

3. Testing equipment
    a. Testing block
    b. Testing hook
    c. Two 5 gal. plastic pails per testing station
    d. Clean sand for weight
    e. Balance scale
    f. Calculator

V. JUDGING

A. Contestants shall be ranked in numerical order on the basis of the efficiency determined by the following formula:

$$\text{EFFICIENCY} = \frac{\text{Failure Weight}}{\text{Weight of bridge}}$$

B. The finished bridge will be weighed and entered in the formula as "Weight of bridge."

C. An increasing load will be applied to the bridge via the test hook until the bridge fails. The load will be weighed and entered in the formula as "Failure Weight."

HISTORY OF BRIDGE DEVELOPMENT

Basic bridge designs are developed from natural bridges—a tree trunk that has fallen across a stream, vines hanging over a river, or stones that make a stepping-stone path across a shallow stream. These natural bridges were probably built upon by ancient bridge builders. For example, someone may have built up the stepping stones, placed flat stone slabs or logs on top of them, and connected the stones to create a low bridge. This type of bridge is called a "clapper bridge." It is one of the earliest bridge constructions. Such simple bridges are probably still built today in many places. In general, though, bridge construction has changed greatly.

The ancient Romans refined bridge building with two important contributions. Nearly all of their bridges used the arch design—a structure that can support more weight than a flat surface can. Also, the Romans' discovery of natural cement allowed them to build strong, long-standing bridges. Many of these ancient Roman bridges are still standing today.

There were excellent bridge builders in Asia, too. Some early bridges in Asia used a cantilever design. This design enabled the builder to make simple, long-span bridges across fairly wide rivers. One famous bridge in China, built about 1300 years ago, is the Great Stone Bridge. Its graceful arch shape is not the same type of arch used by the Romans. Instead, this bridge is quite low, and the arch is very shallow.

The Renaissance brought new scientific ideas to bridge building. Leonardo da Vinci and Galileo developed theories about the strength of building materials. Their theories have helped architects understand how to make strong structures from lightweight materials. Bridge building became more exact as people began to use more mathematical theories about it. Another new development that changed bridge building was the development of metal.

About 200 years ago, the first cast-iron bridge was built. This was the Iron Bridge at Coalbrookdale in England. Before that time, bridges were made of stone, brick, clay, or timber. Eventually, wrought iron was used instead of cast iron. Much later, steel was used. Many new bridge designs were created and tested during this time. The Britannia Tubular Bridge, completed in 1850, showed one such new development. It was built from rectangular tubes of wrought iron. Similar tube sections are often used in bridges today.

Other important developments came with the truss bridge and the suspension bridge designs. The truss is an old design, but it was improved when engineers knew enough about science and mathematics to work out the mechanics of the design. Covered bridges were usually built on the truss design. Truss bridges were improved even more when metal was used. The suspension bridge was another basic design that was changed by the use of metal. The Brooklyn Bridge is one famous suspension bridge built during this time. It uses steel wires for the suspending cables.

About a hundred years ago, engineers began using concrete for bridges. A new method called "prestressing" helps prevent concrete from cracking after a structure is built. Today, most new bridges are made of prestressed concrete and steel.

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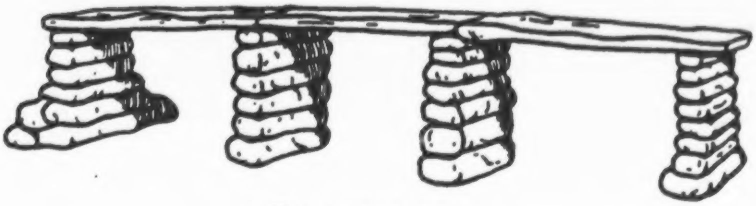
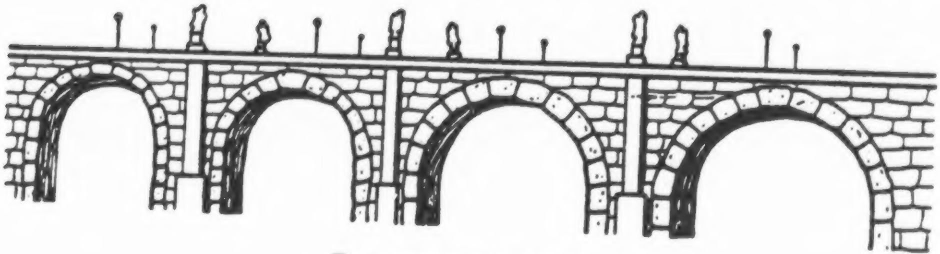
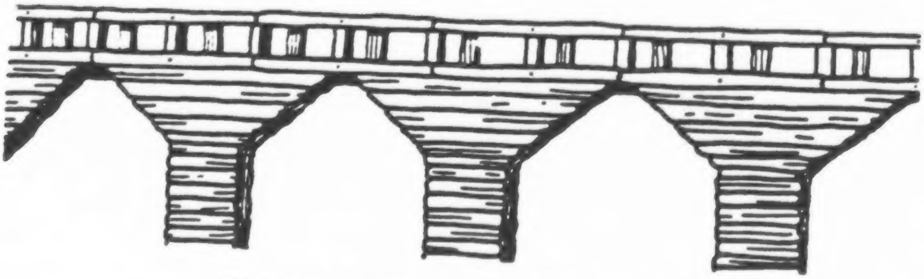
HISTORY OF BRIDGE DEVELOPMENT



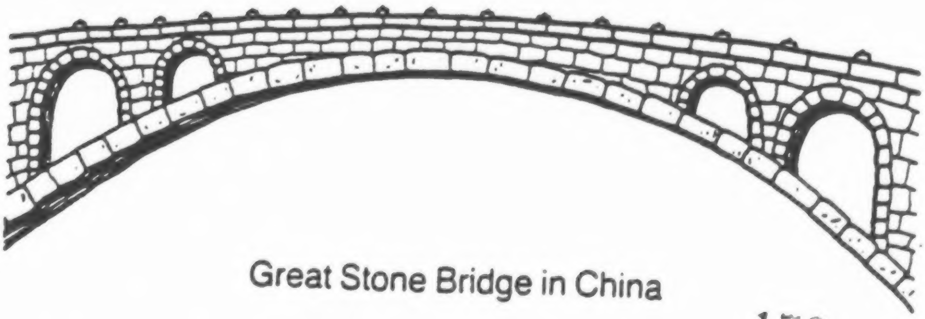
Clapper bridge



Roman arch bridge



Timber cantilever bridge design



Great Stone Bridge in China

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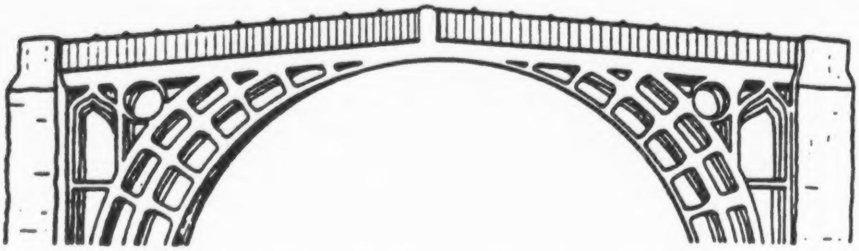
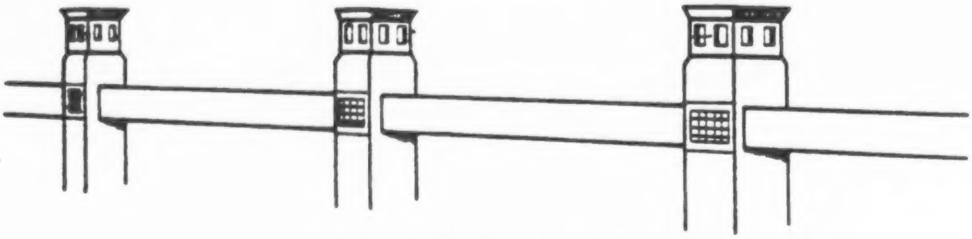
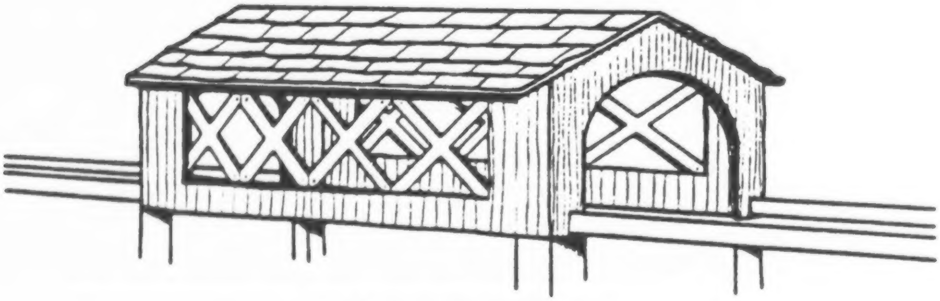
HISTORY OF BRIDGE DEVELOPMENT



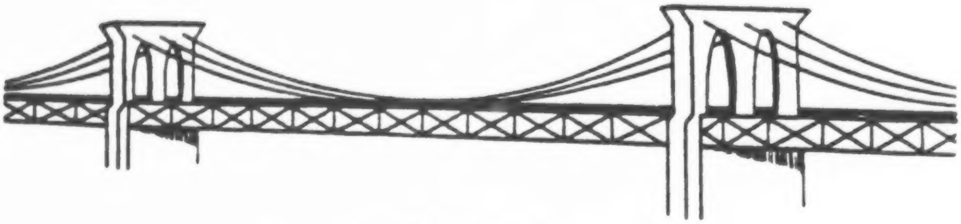
First Cast-Iron Bridge at Coalbrookdale



Britannia Tubular Bridge



Covered bridge



Brooklyn Bridge

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Mackinac Bridge Authority
St. Ignace, Michigan
(Revised 10/85)

HISTORY

MACKINAC BRIDGE

A newspaper, the Lansing Republican, dated February 5, 1884, reprinted a story from the Grand Traverse Herald pointing out that the experiment to provide all-year service across the Straits by boat had failed, and that if a great east-west route were ever to be established through Michigan a bridge or tunnel would be required. The editor considered both as practicable; the only question in his mind was that of cost.

The dedication of the Brooklyn Bridge in 1883 gave Mackinac Bridge backers encouragement. A St. Ignace store owner in 1884 reprinted an artist's conception of the famous New York structure in his advertising and captioned it "Proposed bridge across the Straits of Mackinac."

On July 1, 1888, the board of directors of the famous Grand Hotel at Mackinac Island held their first meeting and the minutes show that Commodore Cornelius Vanderbilt said: "We now have the largest, well-equipped hotel of its kind in the world for a short season business. Now what we need is a bridge across the Straits." The great Firth of Forth Bridge in Scotland was under construction then and completed in 1889.

During the ensuing years there were a few farfetched ideas about the connection of Michigan's two peninsulas. In 1920 the state highway commissioner suggested a floating tunnel. He invited other engineers to suggest ideas for crossing the Straits. Mr. C.E. Fowler of New York City came forward with an ambitious project to solve the problem with a series of bridges and causeways that would start at Cheboygan, some 17 miles southeast of Mackinaw City, traverse Bois Blanc and Round Islands, touch the southern tip of Makcinac Island, and leap across the deep channel to St. Ignace.

In 1923 the Legislature ordered the State Highway Department to establish a ferry service at the Straits. Within five years traffic on this facility became so heavy that the late Governor Fred Green ordered the same agency to make a study of bridge feasibility. The report was favorable and its cost was estimated at 30 million dollars. Some strides to get the project underway were taken but it was eventually dropped.

Writing in the Michigan Alumnus-Quarterly Review. spring 1937, the late James H. Cissel, Secretary of the Mackinac Straits Bridge Authority, said:

> "Early in 1934 the matter was again revived and proposed as a suitable P.W.A. project. In the extra session of 1934 the Legislature created the Mackinac Straits Bridge Authority of Michigan and empowered it to investigate the feasibility of such construction and to finance the work by issuance of revenue bonds. The Authority began its studies in May 1934 and has been continuously active since that date.
>
> "Although limited funds precluded full and complete preliminary studies, the Authority was able to reach the conclusion that it was feasible to construct a bridge directly across the Straits at an estimated cost of not more than $32,400,000, for a combined two lane highway and one-track railway bridge. In its studies the Authority utilized soundings made by the War Department Engineers and was aided by the gratuitous counsel and advice of engineers and contractors experienced in work of this magnitude."

The Authority made two attempts between 1934 and 1936 to obtain loans and grants from the Federal Emergency Administration of Public Works, but P.W.A. refused both applications despite endorsement by the U.S. Army Corps of Engineers and the report that the late President Roosevelt favored the bridge.

Notwithstanding these setbacks, bridge backers resumed their efforts with their usual vigor. From 1936 to 1940 a new direct route was selected, borings were made, traffic, geologic, ice and water current studies of a very comprehensive nature were completed. A mole or causeway jutting 4,200 feet into the Straits from St. Ignace south was constructed. Preliminary plans for a double suspension span were drawn and the possibility of a bridge became very real. But the Armies of Europe began to march and bridge progress came to a halt. Finally, in 1947, the State Legislature abolished the Mackinac Straits Bridge Authority.

Again, the bridge backers swung into action and a citizens' committee was established to obtain legislation recreating a bridge authority. By 1950 the legislation was enacted, but it limited the newly created Authority to determine feasibility only. The law required the Authority to consult with three of the world's foremost long span bridge engineers and traffic consultants for advice on physical and financial feasibility.

In January of 1951 the Authority submitted a very favorable preliminary report, stating that a bridge could be built and financed with revenue bonds for $86,000,000, but because of the shortage of materials due to the Korean outbreak, legislation to finance and build the structure was delayed until early in 1952. Immediately, the Authority asked the Reconstruction Finance Corporation to purchase $85,000,000 worth of bonds.

While this agency was studying the request a private investment banker became interested in the project, and offered to manage a group of investment companies which would underwrite the sale of the bonds. The Authority accepted the offer and was ready to offer its bonds for sale by March of 1953. There were not enough takers to guarantee successful underwriting. The money market had weakened.

In order to make the bonds more attractive, the Legislature passed an act during the spring of 1953 whereby the operating and maintenance cost of the structure, up to $417,000 annually, would be paid for out of gasoline and license plate taxes. Another effort to finance with this added inducement in June of 1953 was likewise unsuccessful, but toward the end of the year the market recovered and $99,800,000 worth of Mackinac Bridge bonds were bought by investers all over the country. Contracts which had been awarded contingent upon this financing were immediately implemented.

The five-mile bridge, including approaches, and the world's longest suspension bridge between cable anchorages, had been designed by the great engineer Dr. David B. Steinman. Merritt-Chapman & Scott Corporation's $25,735,600 agreement to build all the foundations led to the mobilization of the largest bridge construction fleet ever assembled. The American Bridge Division of United States Steel Corporation, awarded a $44,532,900 contract to build this superstructure, began its work of planning and assembly. In U.S. Steel's mills the various shapes, plates, bars, wire and cables of steel necessary for the superstructure and for the caissons and cofferdams of the foundation, were prepared. The bridge was officially begun amid proper ceremonies on May 7 & 8, 1954, at St. Ignace and Mackinaw City.

The bridge opened to traffic on November 1, 1957 according to schedule, despite the many hazards of marine construction over the turbulent Straits of Mackinac. While traffic never met the highly optimistic predictions of the experts, the revenues of the Bridge have always been sufficient to meet its obligations. At the end of 1984, all but $6,962,000 of the original bond issue had been retired, and it is expected that the remaining bonds will be retired by the end of 1986, eight years ahead of maturity.

Interesting Facts on the Mackinac Bridge*

MIRACLE BRIDGE AT MACKINAC

IMPORTANT DATES

Mackinac Bridge Authority Appointed	June, 1950
Board of Three Engineers	June, 1950
Report of Board of Engineers	January, 1951
Financing and Construction Authorized by Legislature	April 30, 1952
D. B. Steinman Selected as Engineer	January, 1953
Preliminary Plans and Estimates Completed	March, 1953
Construction Contracts Negotiated	March, 1953
Bids Received for Sale of Bonds	December 17, 1953
Towers Completed to Full Height	November, 1955
Worst Storm (76 miles per hour)	November 16, 1955
South Backstay Span Floated to Position	November 19, 1955
North Backstay Span Floated to Position	December 18, 1955
Second Winter Shut-Down	December 19, 1955
Cable Spinning Commenced	July 18, 1956
Cable Spinning Completed	October 19, 1956
Third Winter Shut-Down	December, 1956
Final Gap Closed With Steel	May 17, 1957
Erection of Suspended Spans Completed	July, 1957
Scheduled Opening of Bridge to Traffic	November, 1957
Formal Dedication of the Bridge	June 25-28, 1958
Bonds Sold and Financing Completed	February 17, 1954
Engineers' Precise Surveys Commenced	March 6, 1954
Floating Equipment Assembled for Construction	March, 1954
Construction Commenced (Foundations)	May, 1954
Anchorages Completed to Elevation Plus 10	November, 1954
First Winter Shut-Down	January 14, 1955
Pier No. 19 Reached Bedrock	April 30, 1955
Pier No. 20 Reached Bedrock	May 6, 1955
Concreting Record Established (6,250 cubic yards in a single pier in one day)	May, 1955
Steel Erection Commenced (Main Towers)	July 2, 1955

DESIGN AND DETAIL DRAWINGS

Total Number of Engineering Drawings	4,000
Total Number of Blueprints	85,000

MEN EMPLOYED

Total, at the Bridge Site	3,500
At Quarries, Shops, Mills, etc	7,500
Total Number of Engineers	350

LENGTHS

Total Length of Bridge (5 Miles)	26,372 Ft.
Total Length of Steel Superstructure	19,243 Ft.
Length of Suspension Bridge (including Anchorages)	8,614 Ft.
Total Length of North Approach	7,129 Ft.
Length of Main Span (between Main Towers)	3,800 Ft.

HEIGHTS AND DEPTHS

Height of Main Towers above Water	552 Ft.
Maximum Depth to Rock at Midspan	Unknown
Maximum Depth of Water at Midspan	295 Ft.
Maximum Depth of Tower Piers below Water	210 Ft.
Height of Raodway above Water at Midspan	199 Ft.
Underclearance at Midspan for Ships	155 Ft.
Maximum Depth of Water at Piers	142 Ft.
Maximum Depth of Piers Sunk through Overburden	105 Ft.

CABLES

Total Length of Wire in Main Cables	42,000 Miles
Maximum Tension in Each Cable	16,000 Tons
Number of Wires in Each Cable	12,580
Weight of Cables	11,840 Tons
Diameter of Main Cables	24½ Inches
Diameter of Each Wire	0.196 Inches

CONCRETE

Total Concrete in Bridge	466,300 Cu. Yds.
Total Concrete in Substructure	451,000 Cu. Yds.
Total Concrete in one Anchorage (No. 22)	91,600 Cu. Yds.
Total Concrete in One Pier (No. 19)	80,600 Cu. Yds.
Total Concrete in Superstructure	15,300 Cu. Yds.

WEIGHTS

Total Weight of Bridge	1,024,500 Tons
Total Weight of Concrete	931,000 Tons
Total Weight of Substructure	919,100 Tons
Total Weight of Two Anchorages	360,380 Tons
Total Weight of Two Main Piers	318,000 Tons
Total Weight of Superstructure	104,400 Tons
Total Weight of Structural Steel	71,300 Tons
Weight of Steel in Each Main Tower	6,500 Tons
Total Weight of Cable Wire	11,840 Tons
Total Weight of Concrete Roadway	6,660 Tons
Total Weight of Reinforcing Steel	3,700 Tons

RIVETS AND BOLTS

Total Number of Steel Rivets	4,851,700
Total Number of Steel Bolts	1,016,600

BASIC BRIDGE TYPES

There are three basic types of bridges—beam, arch, and suspension. Bridges made to be a combination of such types are called "composite" bridges. Each of the different types of structure holds weight in a different way. In other words, a beam bridge supports weight differently than a suspension or arch bridge does, and so on. It is the balance between the downward forces (weight and gravity) and the upward forces (the supports) that allows a bridge to stand and to carry weight.

BEAM BRIDGES

A simple beam bridge is flat across and supported at the two ends. A longer beam bridge may also be held up along its middle by piers that stand in the river. The weight of the bridge itself, plus any load it carries, plus gravity, are the downward forces acting on the beam bridge. These downward forces are spread evenly across the length of the bridge. The upward forces that hold the bridge up come from the piers.

ARCH BRIDGES

A simple arch bridge reaches across the river in an arching shape rather than straight across the river. Gravity, the weight of the bridge, and the weight of its load all create the downward force. But since the bridge is curved, this force becomes a downward, *outward* force. Rather than the force being spread evenly along the bridge surface, it is concentrated on the end supports. Some arch bridges have a series of arches under the surface. On other arch bridges, the arch actually reaches above the deck of the bridge.

SUSPENSION BRIDGES

A simple suspension bridge droops down between the two ends that hold it up. The droop causes the downward force to go *inward* as well. A modern suspension bridge has towers above the bridge's surface that carry cables to hold up the bridge.

DIFFERENT TYPES OF BEAM BRIDGES

There are several common variations of the beam bridge mentioned earlier. A clapper bridge is a simple, shallow kind of beam bridge that just connects "stepping stones" across the stream. A floating pontoon bridge is another kind of beam bridge, supported by the upward force of the water. Another type of beam bridge is the truss, which is lightweight but strong because of the open, diagonal (or triangular) beams along the sides. There are many different truss designs. Generally, the deck of a truss bridge goes straight across the river, without support at the middle.

The cantilever is a fourth kind of beam bridge. This kind of bridge is supported on two levers that are weighted by piers. The downward force at the center of the bridge is counteracted by the weights. This design allows engineers to build longer span beam-type bridges.

Engineers must consider many things before deciding which bridge design to use. They must consider how long the bridge must be, what it will be used for, how strong the riverbed earth is. The engineers also have to consider the effect of the river current (or ocean tide) on the bridge supports. Weather is another important factor. If the area is very windy or has sudden weather changes, the engineers may not want to design a suspension bridge, for example. The goal of a bridge engineer is to design the strongest, safest, most long-lasting, and economical bridge possible.

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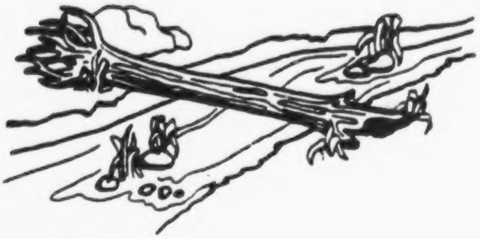
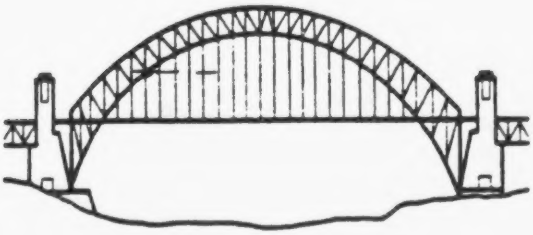
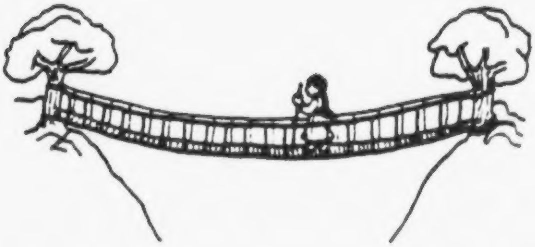
BASIC BRIDGE TYPES



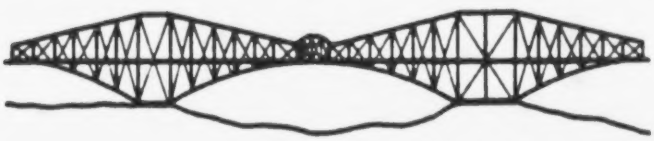
Beam-type bridge



Arch bridge



Suspension-type bridge



Cantilever bridge

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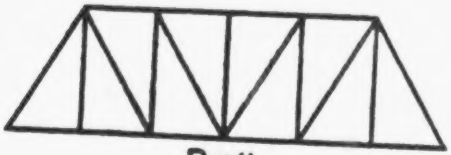
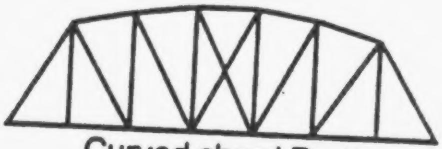
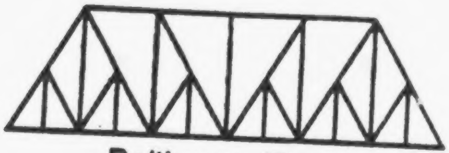
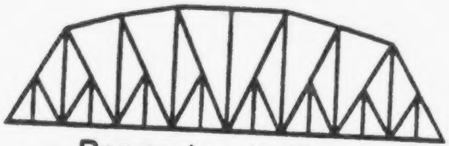
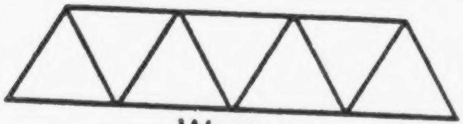
TRUSS BRIDGE DESIGNS

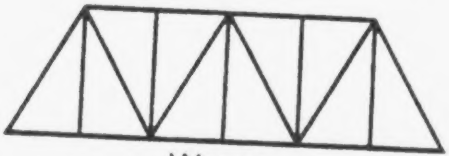

Pratt

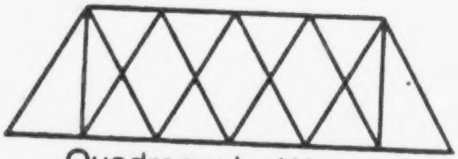

Curved chord Pratt

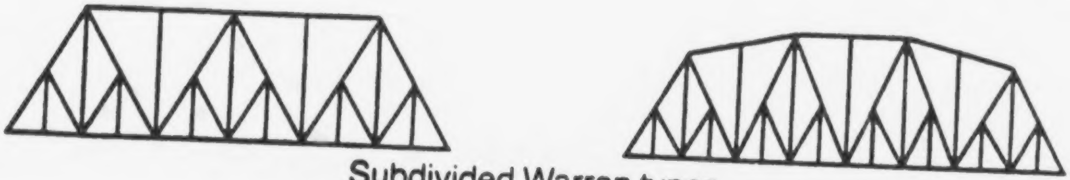

Baltimore (Pratt)

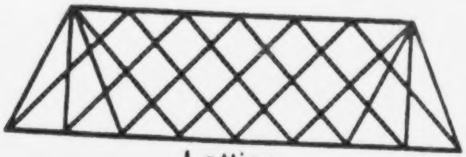

Pennsylvania (Pratt)

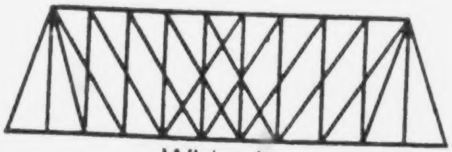

Warren
(without vertical supports)


Warren
(with vertical supports)


Quadrangular Warren


Subdivided Warren types


Lattice


Whipple

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Michigan's Five Big Bridges

The Houghton-Hancock Bridge is a double-deck, lift span of 268 feet, with a four-lane highway on the upper level and a railroad track on the lower level. It can be raised like an elevator to a height 100 feet above the water. When neither trains nor large boats are expected, the railroad level can be raised to the auto level, permitting auto traffic to cross on the railroad deck while small boats pass underneath. This toll-free bridge carries US-41 across the Portage Lake waterway, a ship canal used as a short cut across the Keweenaw Peninsula. It was built by the Department of Transportation and completed in 1959 at a cost of $11 million.

The International Bridge a series of eight arch and truss spans, crosses the St. Marys River and the famous Soo Locks between Sault Ste. Marie, Michigan, and Sault Ste. Marie, Canada. The two-mile-long toll bridge was completed in 1962 at a cost of $20 million and was financed by the American and Canadian governments, the State of Michigan and the Province of Ontario. The two-lane span rises to a height of 124 feet above low-water level to permit passage of ships.

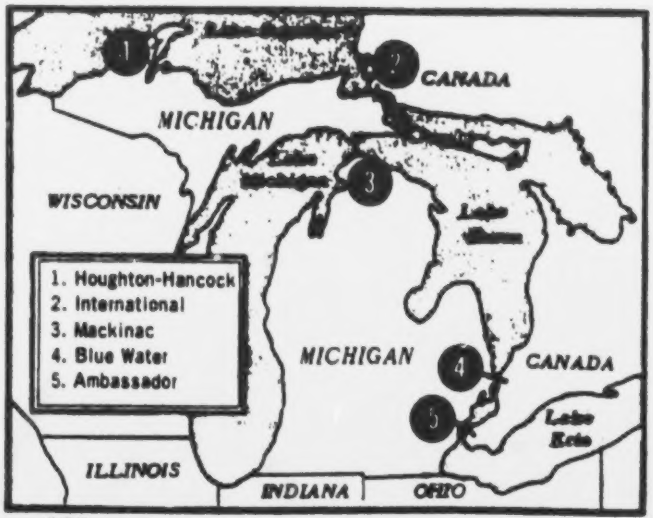
The Mackinac Bridge pronounced "MACK-in-awe" - is the $100 million fulfillment of a century-old dream of bridging the Straits of Mackinac and connecting the two peninsulas of Michigan. Completed in 1957 after four years' labor by 10,000 men, the four-lane span from approach to approach stretches for five miles from Mackinaw City in the Lower Peninsula to St. Ignace in the Upper Peninsula. Length of the center suspension is 3,800 feet and distance between anchorages is 8,614 feet. Underclearance for passage of ships is 155 feet.

The Mackinac bridge was financed by the sale of bonds and is operated by the Department of Transportation through the Mackinac Bridge Authority.

It carries I-75 across the Straits of Mackinac on the route to Sault Ste. Marie, Michigan, and Sault Ste. Marie, Canada, and to connections with US-2 and M-28 leading west across the Upper Peninsula.

The Blue Water Bridge crosses the St. Clair River from Port Huron, Michigan, to Sarnia, Canada at the lower end of Lake Huron. This toll bridge was completed in 1938 at a cost of $4 million and was financed jointly by the American and Canadian governments, the State of Michigan and the Province of Ontario. It is a three lane, cantilever truss bridge. Length of the main span is 871 feet. Total length is one and four-tenths miles. Underclearance is 152 feet. Interstate 94 and M-25 lead to the bridge approaches.

The Ambassador Bridge is a suspension-type span like the Mackinac bridge. It crosses the Detroit River between downtown Detroit and Winsor, Canada. It has a four-lane main span of 1,850 feet and a clearance above water of 152 feet. This toll bridge was completed in 1929 at a cost of $22 million and is privately owned by the Detroit International Bridge Co. Several major Michigan highways, including I-75, US-12, I-94 and I-96 pass within a short distance of its approaches.

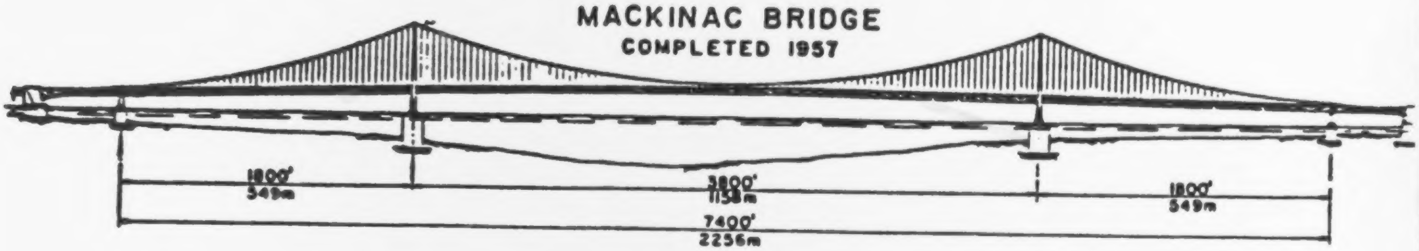


THE WORLD'S FIVE LONGEST BRIDGES

COMPARATIVE MAGNITUDES

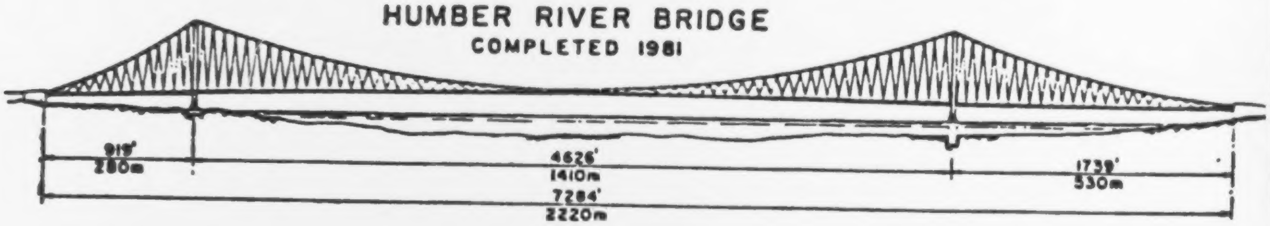
MACKINAC BRIDGE

COMPLETED 1957


1800'
549m
3800'
1158m
1800'
549m
7400'
2256m

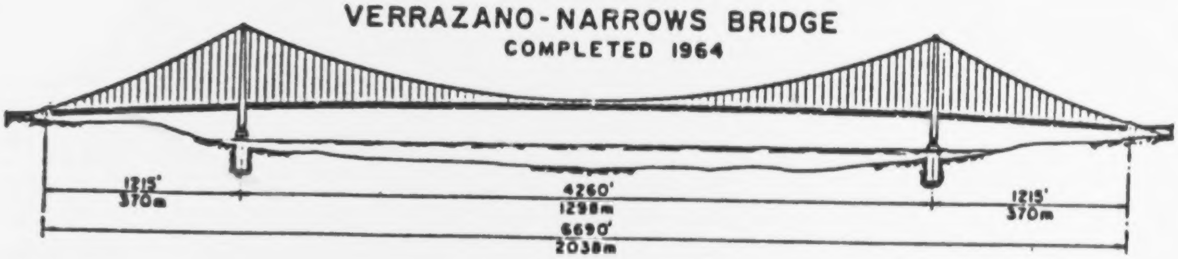
HUMBER RIVER BRIDGE

COMPLETED 1981


919'
280m
4626'
1410m
1739'
530m
7284'
2220m

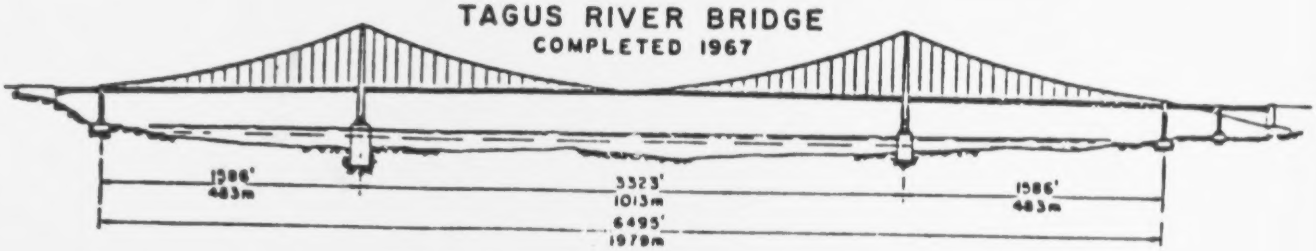
VERRAZANO-NARROWS BRIDGE

COMPLETED 1964


1215'
370m
4260'
1298m
1215'
370m
6690'
2038m

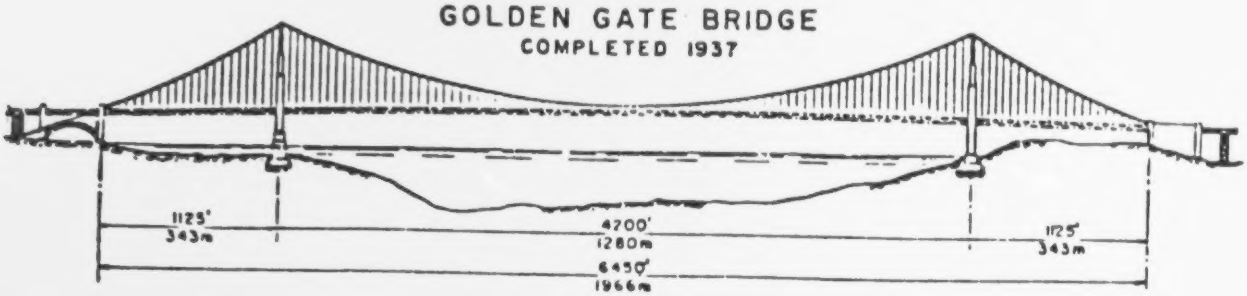
TAGUS RIVER BRIDGE

COMPLETED 1967


1586'
483m
3323'
1013m
1586'
483m
6495'
1979m

GOLDEN GATE BRIDGE

COMPLETED 1937


1125'
343m
4700'
1280m
1125'
343m
6450'
1966m

Applied Math & Science Principles

Stress

Fulcrums

Gravity

Strength of geometric shapes

Measuring

Vibration

Social / Environmental Impact

The definition of a bridge is, "A structure erected to span natural or artificial obstacles, such as rivers, highways, or railroads, and supporting a footpath or roadway for pedestrian, highway, or railway traffic. By siting examples of each of these types you can see how bridges have provided easy access to areas once difficult if not impossible to get to.

Creative Problem Solving Activities

1. Use the bridge contest as a part of your unit.
   Upon completion of the testing of the bridge have the student or students that designed the bridge inspect and evaluate why the bridge failed. Have them explain how they would change their design to improve the efficiency.

2. Obtain the video tape, "The Mackinac Bridge Diary" from REMC Center in your region and show it to the class. Discuss the social and environmental impact the Mackinaw Bridge has had on the State of Michigan. Also discuss other alternative methods passageways could have been opened without the Mackinaw Bridge having been built.

Related Careers

Engineering

Construction

References

Building Toothpick Bridges, Jeanne Pollard; Dale Seymour Publications, Copyright 1985.

AIASA Bridge Building Contest (8-85)

McGraw Hill Encyclopedia of Science and Technology, Copyright, 1980. McGraw-Hill Book Company, Inc. Volume 2, pages 331-338.

A Unit of Instruction on Construction Management and Bridge Building, Harold E. Richards; Harnford Secondary School, Richland, Washington. Presented at ITEA Annual Conference, Kansas City, MO, 1986.

Definition of Terms

ABUTMENTS: The end foundations on which the bridge superstructure rests.

ARCH BRIDGE: A bridge structure with a curved center that when subjected to vertical loads develops at its two end supports reactions with inwardly directed horizontal components.

BEAM BRIDGE: A simple flat bridge supported at the two ends.

SPAN: The spread or distance from one support to another of a bridge.

SUSPENSION BRIDGE: A suspension bridge is a structure consisting of either a roadway or a truss suspended from two cables which pass over two toers and are anchored by backstays to a firm foundation.

TRUSS BRIDGE: A bridge design which usually uses truss members running parallel to the roadway with diagonal and vertial members between them forming a web system.

Activities for Teaching Technology

Activity Title MAJOR PROBLEM SOLVING THROUGH CONSTRUCTION

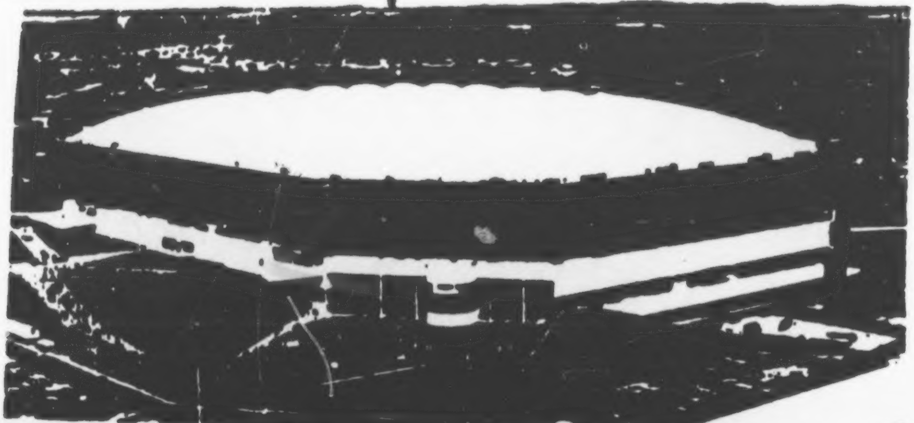
Contributor ED BALL

Time Required 2-4 WKS

Activity Description The student will build a model structure or superstructure. Involved will be the problem solving areas of environment, materials, cost, parking and transportation systems, power supply and whatever more you see fit. During this lab the student will learn "heavy construction" areas as well as a hands-on activity to reinforce this unit's content.

Terms

FOUNDATION
BEARING SURFACE
BEARING WALL
BUILDING CODES
FRAME STRUCTURES
SUPERSTRUCTURE
SITE PLANNING
STRUCTURE



Objectives

To become acquainted with the areas of construction technology.

To study developments in construction technology.

To explore social/economic impacts construction has on society.

To exercise problem solving skills through required laboratory activities.

To construct a scale model structure.

To excercise and apply math principles related to simple construction.

To explore construction careers and occupations associated with construction technology.

Special Supplies & Equipment	Supplier
NONE	

Transparency Masters
&
Student Handouts

MATERIALS:

1. Miscellaneous: paper, toothpicks, pipe cleaners, etc.
2. Plywood
3. Styrofoam board
4. Map (township, city or state)
5. Glue
6. Miscellaneous landscaping materials

FOLLOW THESE STEPS TO CONSTRUCT YOUR MODEL STRUCTURE:

1. Pick a structure from the list below or find one yourself. Make sure it is OK'd by the instructor.

    a. STADIUM (60,000 or more people)
    b. DAM (major river or lake)
    c. BRIDGE (more than 5 miles)
    d. HYDRO-ELECTRIC PLANT (city or industrial use)
    e. HIGH-RISE OFFICE BUILDING
    f. NUCLEAR REACTOR PLANT (state use)
    g. AIRPORTS (major)
    h. CORPORATE HEADQUARTERS (major)
    i. ETC.

2. Pick a location on a local, city or state map, and develop a site plan. Include roads, waterways, etc., needed to be added OR eliminated to your structure.

3. Develop on a piece(s) of plywood your structure (to scale), using the best materials available to simulate "real life" materials used in your structure.

4. Research and use information found on a structure(s) similar to yours, recently being built or already built.

5. Prepare an oral report explaining your structure.

Definition of Terms

BEARING SURFACE: A surface or area established to absorb or support a load or weight.

BEARING WALL: A structured wall designed and placed strategically in a building or structure to support a load or weight.

BUILDING CODES: Laws, set up by township, county or state government, that control how people can use the land. They also describe how a structure can be used, occupied, and placed on the land.

FRAME STRUCTURE: The predetermining of materials and shapes, fabricated in place to hold and support other materials in a structure. (Most framing sequencing determines the building's shape.)

FOUNDATION: The supporting base of a wall or structure.

SITE PLANNING: Predetermining the outcome of a place where something is going to be (in this case land.)

STRUCTURE: Something built or constructed as a building or dam.

SUPERSTRUCTURE: A structure built on top of another; that part of the building above the foundation, usually considerably high, round or tall.

Applied Math & Science Principles

Calculating: concrete, board feet, area.

Estimating

Surveying principles

Social / Environmental Impact

Positive and negative aspects of this structure in the community for which it was built:

1. Economic value (positive and negative).
2. Social impact (positive and negative).
3. Environmental impact.
4. Who personally will benefit or not benefit?

Creative Problem Solving Activities

Disposal of Earth

Competitive Bidding

Surveying (from benchmark)

Roadways, Parking, Waterways

Population Study

Traffic Rerouting

Purpose for Construction

Environmental Study

Power Sources

Future Area Use

Related Careers

General Contractor

Estimator

Finish Carpenter

Electrician

Heating and Cooling Specialist

Plumber

Supplier

Delivery Person

*Architect

Inspectors

Surveyor

Mason

Real Estate Agent

Painter

Heavy Equipment Operator

Roofer

Electronic Technician

Insulator

References

Exploring Construction, Richard M. Henak, Goodheart-Willcox Co. Inc., South Holland, Illinois, 1985.

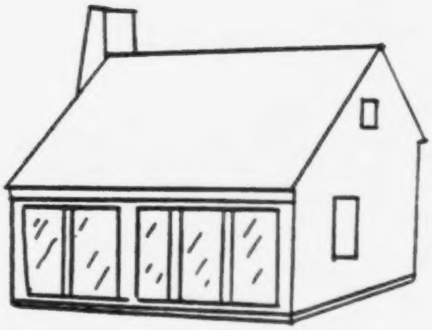
World of Construction, Cox, Ray, Blankenbaker, Umstattd, McKnight, 1982.

Activities for Teaching Technology

Activity Title	SOLAR ENERGY HOUSES
Contributor	ED BALL
Time Required	3 WKS
Activity Description	During the solar unit, the student will discuss many practical uses for the sun's energy. We know that,there are many areas of use (residential, photo chemical, commercial and electrical applications.) The student will build a small model (to scale), that will be used to help reinforce solar power application.

Terms

SOLAR POWER
ACTIVE SYSTEMS
PASSIVE SYSTEMS
COMMERCIAL USE
RESIDENTIAL USE
CONVECTION
CONDUCTION
PHOTOVOLATIC CELLS
THERMAL
RADIATION



Objectives

To gain the understanding of the basic principles of solar power.

To gain an understanding of how the sun's energy can be used to heat a home or business.

To gain experiences in measuring, cutting and assembling through construction of a solar energy model.

To learn that different surface colors and/or materials absorb the sun's energy.

To learn that solar application systems depend highly on direction for maximum efficiency.

To analyze different solar techniques and find out which applications are best and in what conditions.

Special Supplies & Equipment

1. Cardboard 1/8" thick (clean if possible.)
2. 1/4" grid graph paper.
3. Rubber cement.
4. Straws.
5. Color construction paper.

Supplier

Transparency Masters
&
Student Handouts

SOLAR ENERGY HOUSES

MATERIALS:

1. Cardboard (clean if possible.)
2. Construction paper.
3. Saran wrap.
4. Straws.
5. Glue, tape.
6. Scissors.
7. 1/4" graph paper.
8. Miscellaneous materials.

Follow these steps to construct your solar energy project:

1. Pick the area you want to cover: residential or commercial. (If photochemical or photovolatic, build scale model from a picture or another source.)

2. Gather all the necessary equipment and supplies.

3. On a piece of 8½ x 11 graph paper (¼ grid), draw and develop a small house using ¼=1' scale and the walls will be made of 2x6s instead of 2x4s to help with the thickness of the cardboard.

4. Draw a floor plan of a home (one story preferably), with doors and windows. Be sure to add solar if necessary here.

5. Glue floor plan on a 8½ x 11 piece of solid cardboard (no creases.)

6. Pre-cut walls to 1½ height.

7. Build walls up by custom cutting length, doors and windows, and glue with rubber cement to floor plan.

8. Add solar application to house.

9. Use color paper to represent solar tile, shingles, siding, etc. (I use sandwich bags (baggies) to represent solar windows or glass.)

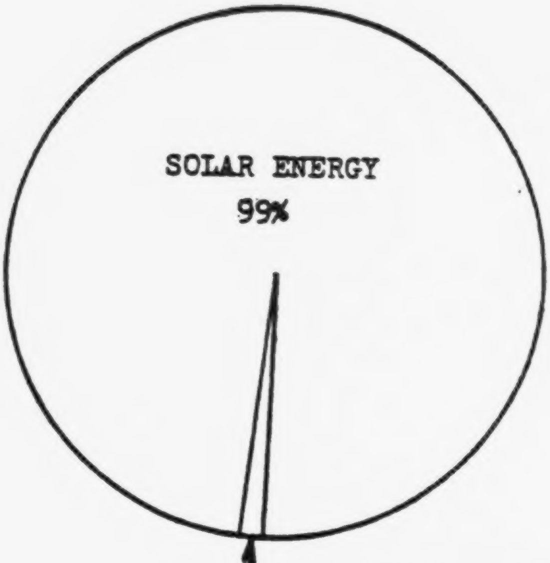
10. On a 5x7 card give the following information:
    a. your name.
    b. product and use (residential, commercial, etc.)
    c. describe what your model's real solar material would be made of and the problems they face (cost, accessibility, etc.)
    d. how it works (scientifically explained -- don't forget sun, direction, movement of heat, active/passive, etc.)
    *e. the importance of your project to the world's overall needs today.

SOLAR POWER: Radiant energy from the sun transformed into work potential by Thermo, Photochemical, or Electrical processes.

- Inexhaustible source of energy
- 99% of all processes on earth are directly or indirectly energized by the sun.

Distribution of the Suns Energy:

- 35% is reflected back into space
- 43% is converted directly into heat
- 22% powers evaporation, precipitation, etc.



1% All fossil fuels and nuclear fuel consumption on earth

** The sun by any measure, is the largest single energy input into the world's economy.

Mans technological capabilities for collecting, storing, and converting solar radiation to perform useful work is at a high level.

I. Types of Solar Energy Harnessing Systems:

(2) Major Types:

- a. Active Systems
- b. Passive Systems

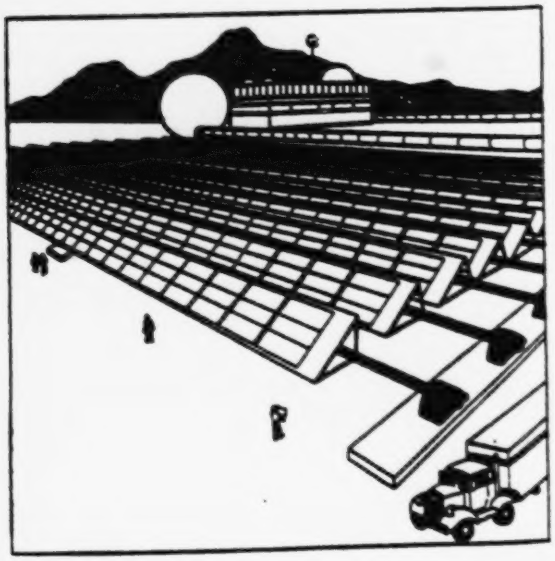
A. Active Systems: A system of a solar heating/cooling unit that uses a mechanical (pump and/or fan) means to move energy where it is needed.

TYPES:

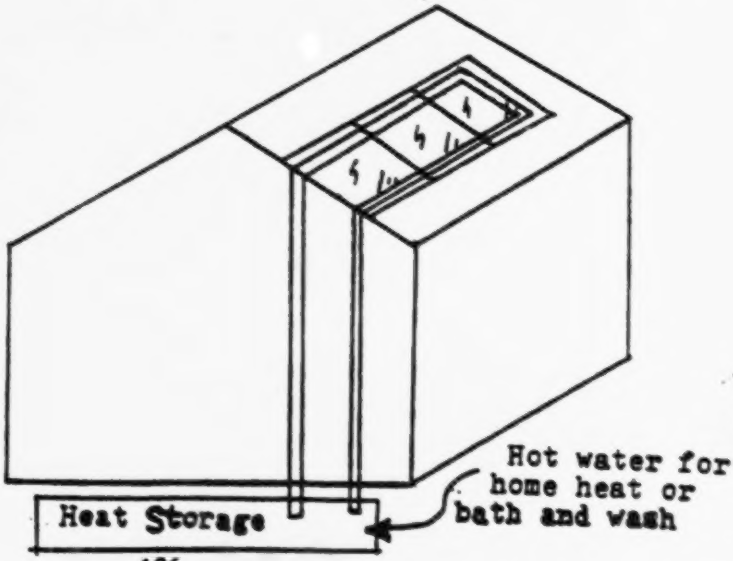
1. Flat Plate Collector: Solar energy strikes a black metal absorber that is encased in an insulated box with a glass or plastic cover.

- Collected heat is transferred to a medium, usually air or liquid.
  - water usually
- Heat then goes to a storage tank of rocks or a tank of hot water.

a) Industrial/Commercial Use



b) Residential Use

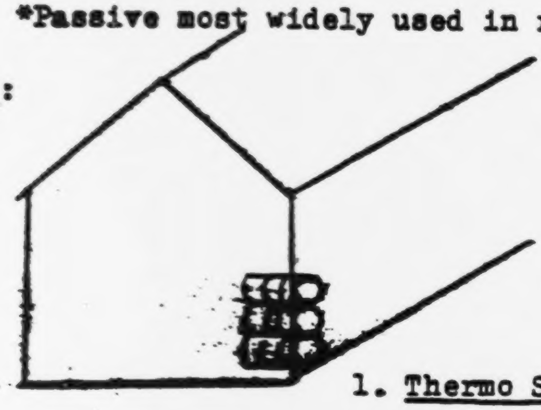


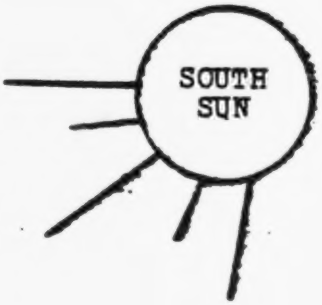
B. **PASSIVE**: A system into which heat energy flows by natural means (conduction, convection, and radiation).

- Stored and ready for use.
- No pumps and/or fans

*Passive most widely used in residential application.

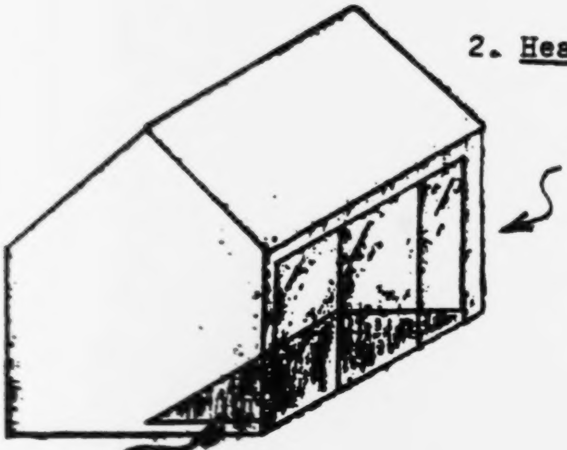
TYPES:





1. Thermo Storage Wall
   - Barrels filled with water

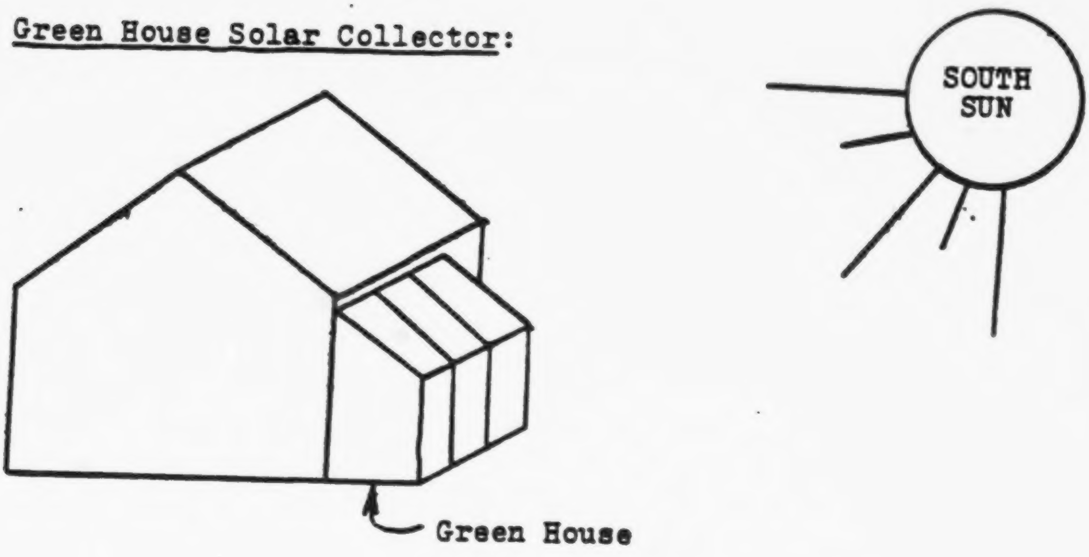
2. Heat Storage Floor



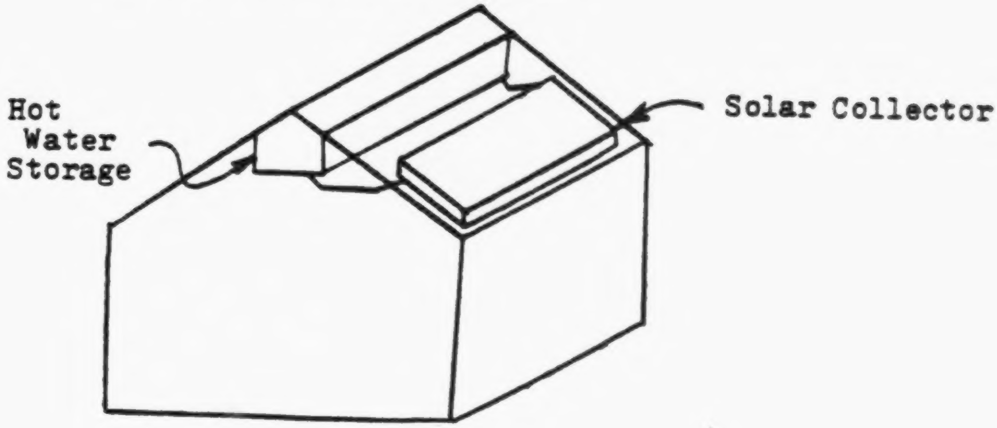
Glass Wall

Heat Storage
- Black Slated Tiles

3. Green House Solar Collector:


SOUTH SUN
Green House
- Plant House
- Large Building or Bay Window

4. Natural Convection Loop:


Hot Water Storage
Solar Collector

Definition of Terms

ACTIVE SYSTEMS: A system of a solar heating/cooling unit that uses a mechanical (pumps and/or fans) means to move energy where it is needed.

COMMERCIAL USE: Used on, or for, a business connected with the making and selling of products for sale or profits.

CONDUCTION: The transfer of heat through a solid.

CONVECTION: The transfer of heat in a fluid or gas by the movement of the fluid itself.

PASSIVE SYSTEM: A system into which heat energy flows by natural means (conduction, radiation, and convection.)

PHOTOVOLATIC CELLS: Cells that produce an electromotive force (voltage) when it is exposed to light.

RADIATION: The process in which energy is projected in the form of rays of light, heat, etc.

RESIDENTIAL USE: Used in or on a home suitable for residence, or home, neighborhood.

SOLAR POWER: Radiant energy from the sun, transformed into work potential by thermo, photochemical, or electrical processes.

THERMAL: (THERMO-) Having to do with heat, (hot or warm.)

Applied Math & Science Principles

the measurement of heat capacity $C = \frac{VI\Delta t}{n\Delta t}$

heat transfer

quantity of heat

the theory behind why solar houses face toward the south

Social / Environmental Impact

1. Discuss the advantages of solar energy to a society. Consider jobs and energy savings.

2. Discuss the disadvantages. Consider jobs and looks.

*3. What impact would solar energy have on the environment if we all (100% of society) converted to solar?

    - Green House Effect
    - ice bergs and water
    - temperature
    - other issues

Creative Problem Solving Activities

1. As a class, build two (or more) identical small model frames of homes out of plywood. Build one to represent a home or building with no solar heat or no additional windows to allow for heat. The second one, place solar windows, tiles, etc. in the construct of it.

   Then place identical thermometers in each house and place in the sun. Take special care to see that the solar home model faces south. Record each home's temperature every day at 3 different times. Draw up a graph comparing the two, and record your findings; plus, explain why what took place in each home and what made it happen.

2. Research a solar pond, photovolatic cell, etc.

Related Careers

- Owner of a solar energy business
- Solar Contractor
- Technician
- Engineer
- Technologist
- Mechanic
- Researcher
- Control Specialist
- Chemist
- Solar Engineer
- Solar Energy Consultant

References

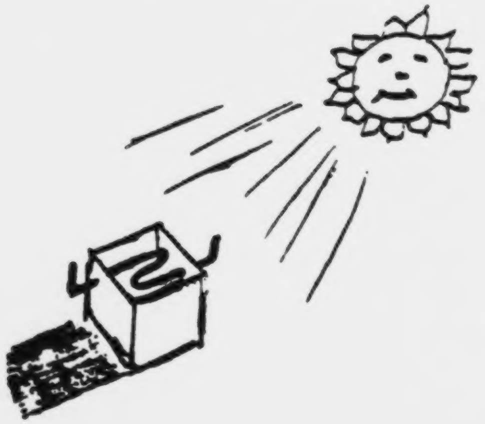
Earth, Energy and Everyone. Medard Gabel. Anchor Press, Doubleday. 1980.

Activities for Teaching Technology

Activity Title	SOLAR HOT WATER HEATER
Contributor	LEE E. SCHAUDE
Time Required	2-3 WEEKS (10-15 DAYS)
Activity Description	The student will construct a solar hot water heater, conduct experiments, and record data. Next the student will add a storage tank and conduct additional experiments.

Terms

CALORIES
CELCIUS
INSULATION
SOLAR COLLECTOR
STORAGE TANK



Objectives

The student should be able to:

Construct a small solar water heater.

Explain how a solar collector works.

Describe how a solar hot water functions.

Compute the number of calories produced by their solar water heater.

Special Supplies & Equipment	Supplier
Galvanized steel	
Cardboard	
Flat black spray paint	
Fiberglass insulation batting	
3/8 Copper tubing	
Small plastic funnel	
Styrofoam cups	
3 mil clear visquen	
Thermometer	
Plastic tubing, 3/8 I.D.	

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&
Student Handouts

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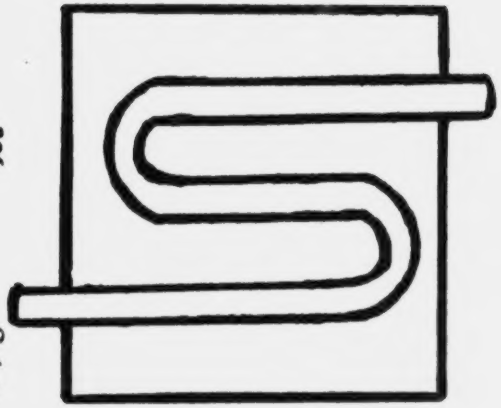
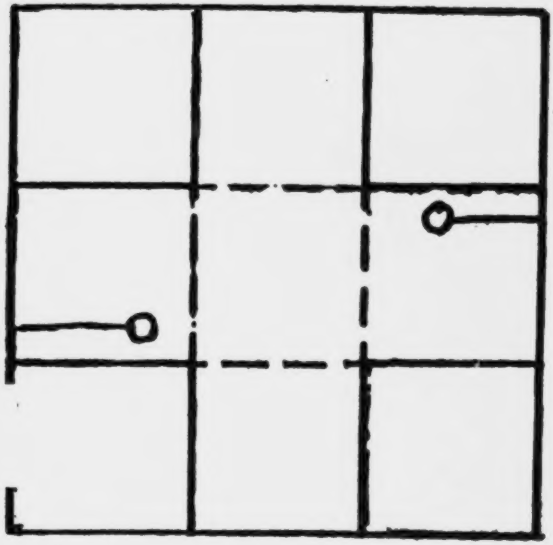


COLLECTOR PLATE

1. BEND COPPER TUBE WITH TUBE BENDER

2. SOLDER TUBING TO GALVANIZE PLATE

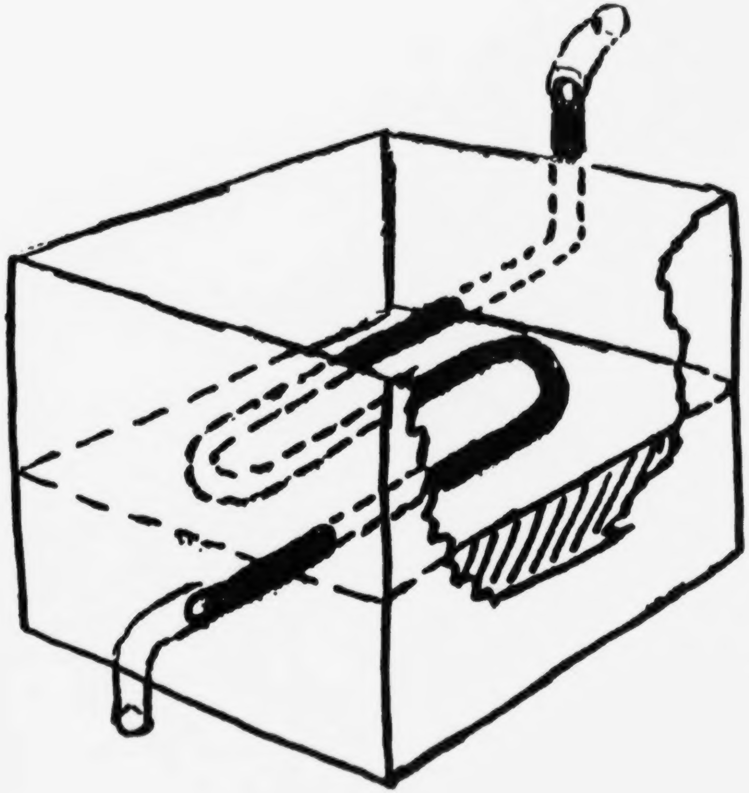
3. PAINT FLAT BLACK



BOX CONSTRUCTION

1. CUT ON SOLID LINES – FOLD ON DOTTED LINES.

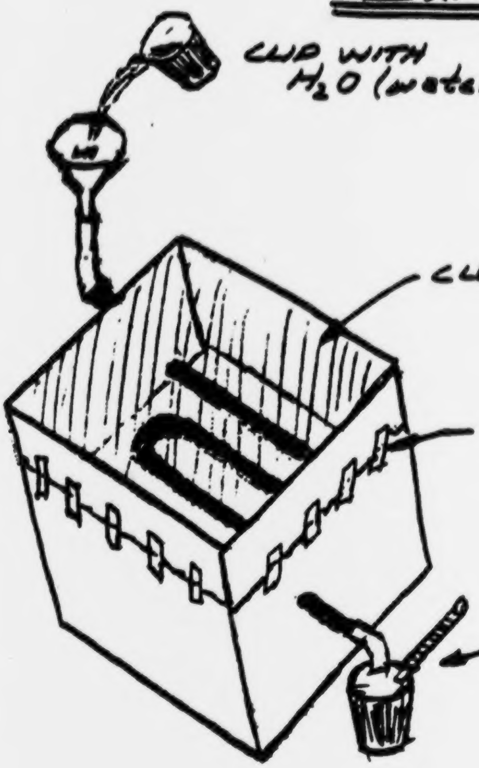
2. CUT HOLES & SLOTS FOR COLLECTOR TUBES



ASSEMBLY

1. FOLD BOX & TAPE ALL SEAMS.
2. INSERT INSULATION & COLLECTOR PLATE
3. COVER TOP WITH CLEAR 3 MIL FILM & TAPE SHUT

EXPERIMENT #1

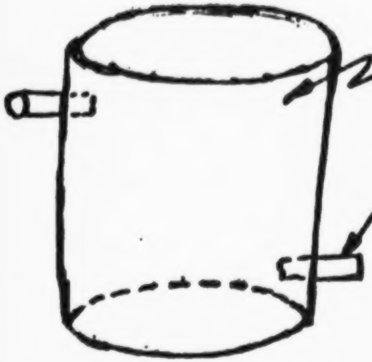

CUP WITH H_2O (water)
CLEAR PLASTIC FILM
TAPE
THERMOMETER IN STYROFOAM CUP

NOTE

PROP BOX SO THAT FILM COVERED OPENING IS FACING SUN

1. MEASURE AND RECORD TEMPERATURE OF 100 ml OF WATER.
2. POUR WATER THROUGH THE TUBE OF THE COLLECTOR PLATE AT 15 SECOND INTERVALS UNTIL THE WATER TEMPERATURE INCREASES 5 °C
3. HOW MANY POURINGS DID IT TAKE?

CONSTRUCTION of STORAGE TANK

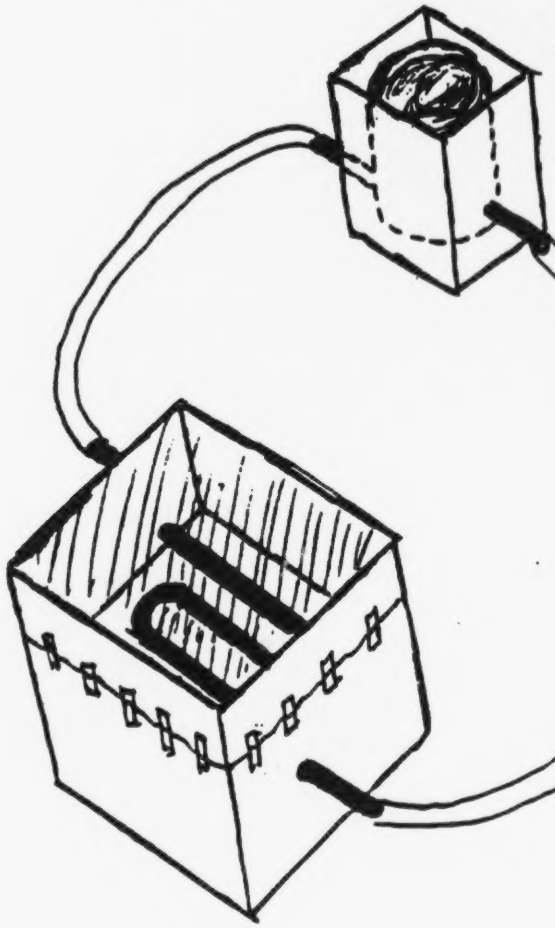


1 LB COFFE CAN

$\frac{3}{8}$ COPPER TUBING SOLDERED IN HOLES $\frac{3}{4}$ FROM TOP AND BOTTOM OF CAN

NOTE INSERT STORAGE TANK IN A CARDBOARD BOX & INSULATE BETWEEN CAN AND BOX WITH FIBERGLAS BATT.

EXPERIMENT #2



NOTE BOTTOM OF STORAGE TANK MUST BE ABOVE THE TOP OF COLLECTOR BOX.

1. FILL ALL TUBING AND CAN WITH WATER. AVOID TRAPPING AIR IN TUBING.
2. RECORD THE TEMPERATURE OF WATER IN STORAGE TANK.
3. PLACE COLLECTOR FACING THE SUN AND PLACE COVER ON STORAGE TANK BOX.
4. ALLOW TO SIT IN SUN FOR 30 MINUTES.
5. HOW MANY DEGREES DID THE WATER TEMPERATURE INCREASE.

DATA SHEET

1. How many pourings in Experiment 1? ____________

2. EXPERIMENT #2

   A. Weight of can only: ________________________

   B. Weight of water in can: ____________________

   C. Water temp at start: _______________________

   D. Water temp at end: _________________________

   E. Weight of water and can after: _____________

   F. CALCULATIONS:

CALORIES = (final temp - starting temp) X weight of water
+
(final temp - starting temp) X 1/20 wt of can

Definition of Terms

CALORIES: The amount of heat needed to raise the temperature of 1 gram of water 1 degree Celsius.

CELSIUS: The temperature system where water freezes at 0 degrees and water boils at 100 degrees.

INSULATION: A material that will delay or prevent the loss of heat to or from a space.

SOLAR COLLECTOR: A device that collects heat from the sun's rays.

STORAGE TANK: A device used to store heat collected.

Applied Math & Science Principles

Calculations, measurement, recording

Solar effects, solar collection

Social/Environmental Impact

Current fossil fuel energy sources have negative effects on our environment. What are they?

What are the advantages and disadvantages of solar energy?

1. Jobs
2. Economics
3. Environment
4. Geographic locations
5. Retrofitting of existing structures

What do you see for the future and solar energy?

Creative Problem Solving Activities

1. What would happen if you used 50 ml of water instead of 100 ml? WHY?
2. What happens if you change the angle of the collector with respect to the sun? WHY?
3. Make a second box and place it above the first box, what happens and why?
4. What is the highest temperature you can reach with your flat-plate collector? How many pourings did it take?
5. Fill the collector with water and allow it to stand for 10 minutes without flowing out. How hot did the water get?
6. Conduct experiment 1 with different solutions of salt and water. Compare these results with your first result, what was the difference and why?
7. Try using your solar hot water heater in reverse at night.
8. What is the highest temperature you can obtain in the experiment #2?

Related Careers

Sheetmetal Worker

Solar Engineer

Heating/Air Conditioning Worker

References

Magnoli, Michael; Experiences in Physical Science; Laidlaw Brothers, River Forest, IL, 1985.

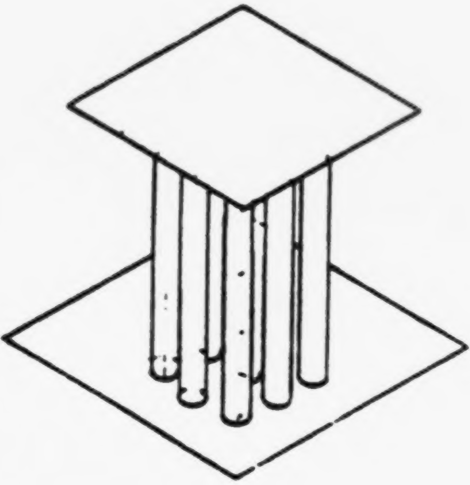
Solar Energy Education; Solar Energy Project, New York State Department of Education; Albany, New York, 1981.

Activities for Teaching Technology

Activity Title	PAPER PLATFORM
Contributor	CHARLES GOSDZINSKI
Time Required	MINIMUM 2 PERIODS (2 HRS)
Activity Description	Students are to construct platform or stage which will support as much weight as possible.

Terms

PLATFORM
STRUCTURAL SHAPES
LOAD BEARING
SPAN
CYLINDERS
TRIANGLES
RECTANGLES



Objectives

As a result of their learning experiences students will:

Determine architectural shapes most conducive to supporting structures.

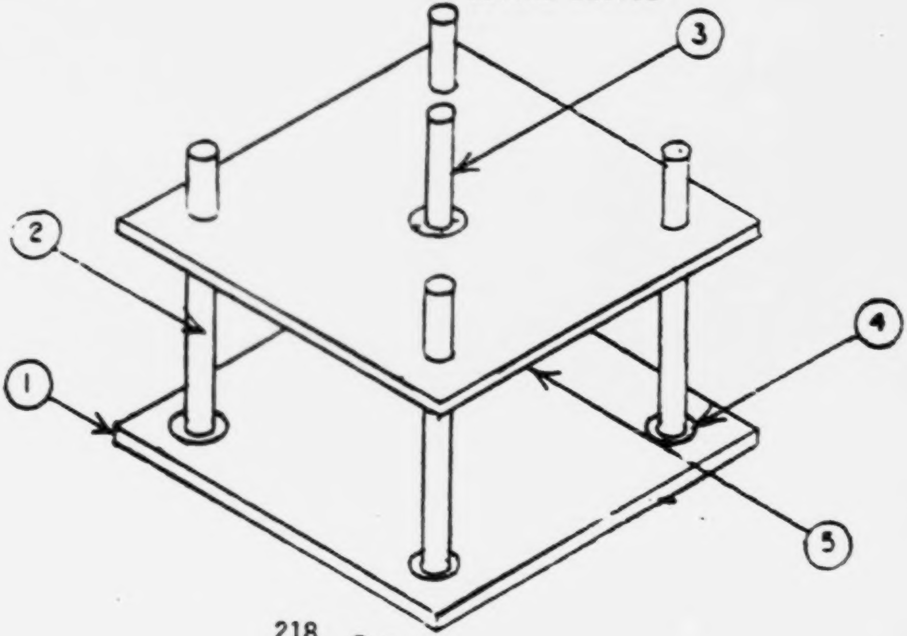
Determine building materials most conducive to support structures.

Construct a structure capable of supporting as much weight as possible.

Special Supplies & Equipment | Supplier

1. 2 pcs. 3/4" plywood 2'x 2'
2. 5 pcs. 1/2" pipe 2' long
3. ½ " or 3/4" for centering lift weight
4. 5 pipe flanges
5. project placed here
6. 1 set of lifting weights

TESTING DEVICE



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Paper Platform

THE PROBLEM: Using only one sheet of standard 8½" x 11" paper, and white glue, construct a platform which will support as much weight as possible.

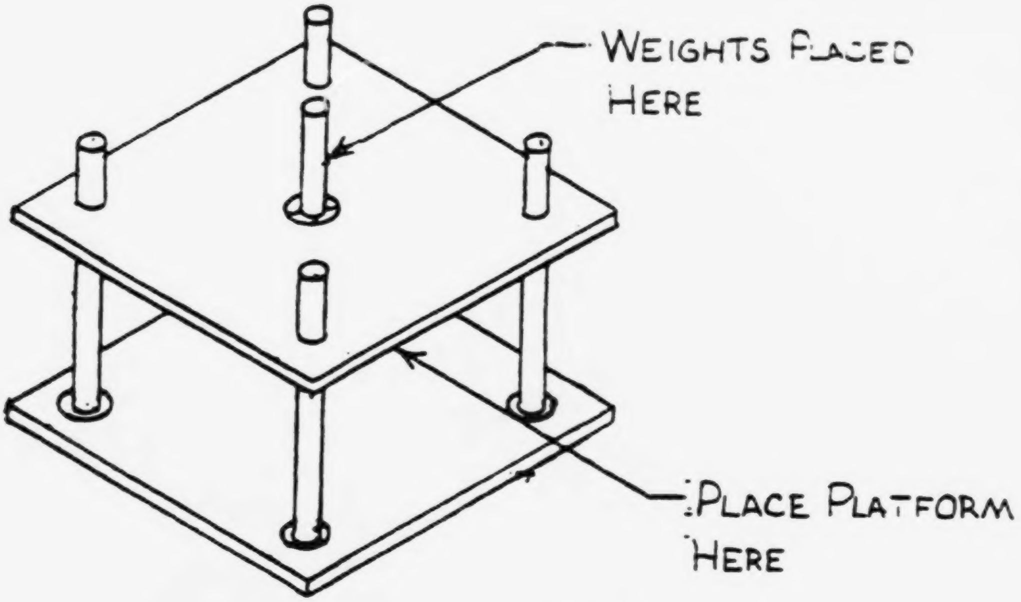
LIMITATIONS:
- Only use one sheet of paper
- Only use white glue
- Cannot use any clamping devices to aid in construction
- Platform must be exactly 3" ± 1/8" tall
- Time limited in construction (optional)
- Specify whether or not glue can be used to fill any hollow shapes supporting the structure.

TESTING PROCEDURE: Your platform will be allowed to dry a minimum of 12 hrs. (overnight) you will place your platform on the floor and test the height with the provided gauge. You may then begin placing weights on top of your structure in any manner you choose until structure collapses.

EVALUATION: +25 points for structure holding most weight
(weight last held for over 30 seconds is final weight)

-1 point for every 5% reduction from most weight
(example - if most weight 100 lbs. 25 pts.
95 lbs. 24 pts.
90 lbs. 23 pts.

-5 points if fails to meet height requirement



TESTING DEVICE

Definition of Terms

SPAN - Horizontal distance between supports

LOAD BEARING - Wall, post or column that supports any vertical load in addition to its own weight

STRUCTURAL SHAPES - Shapes conducive to supporting structures (e.g. triangles, columns, archs.,)

PLATFORM - A horizontal, generally raised, flat surface

Applied Math & Science Principles

Stress and structures

Basic principles of geometry

Social/Environmental Impact

This activity involves problem solving, creativity and critical thinking. Due to the advances of technology, our children will have to change job occupation several times in their lives. Teaching them to think is one more value in the long run than teaching a single skill. You can give a man a fish and he'll eat it for a day, but if you teach him to fish he'll eat for the rest of his life.

Related Careers

Manufacturing Inspector

Production Welder

Data Entry Equipment Operator

Heavy Equipment Operator

Construction Laborer

Crane, Derrick, Hoist Operator

Electrician

Sheet Metal Worker

Structural Iron Worker

Civil Engineer

Drafter

Industrial Engineer

Mechanical Engineer

Heavy Equipment Mechanic

Rivetor and Fastener

Geologist

References

Wilson, Forrest, "Structure: The Essence of Architecture."

Gordon J.E., "Structures or Why Things Don't Fall Down."

Salvador, Mario, "Building: The Fight Against Gravity."

Creative Learning Systems, Inc.
9889 Hibert, Sutie E
San Diego, CA 92131

1-800-621-0852 Ext. 804

Kicklighter, Clois, "Architecture Residential Drawing and Design", 1981, Goodheart-Wilcox Pub.

Activities for Teaching Technology

Activity Title GIRDER STRENGTH TEST

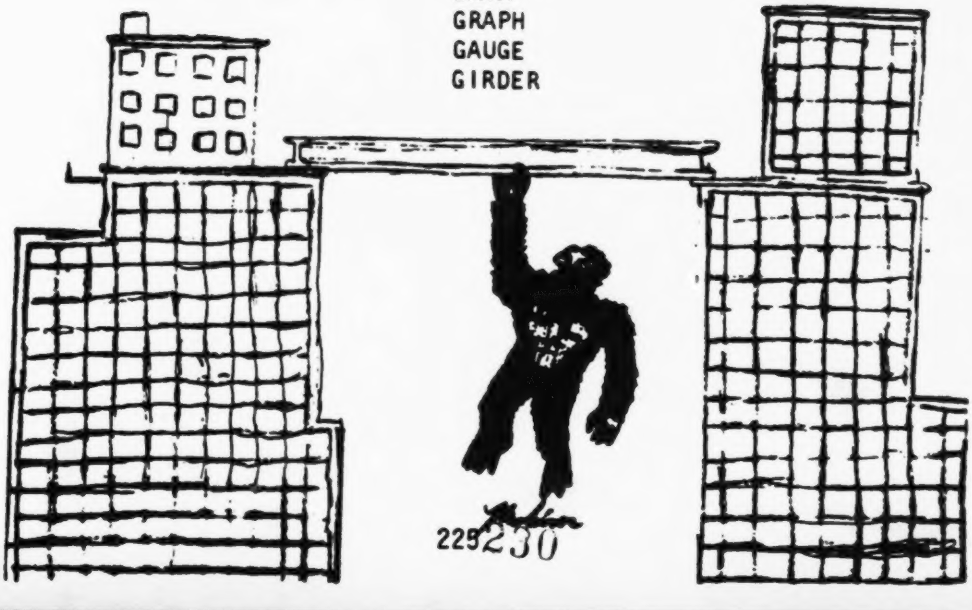
Contributor CHARLES H. MEDDAUGH

Time Required 5 HRS (1 WEEK)

Activity Description In this activity students will test the load bearing capacity of structural girders of various shapes. Through the construction of these girders, students will gain hands-on experience in the use of hand tools, sheet metal machines, and power tools. After a discussion of physics and geometry, each student will attempt to produce a girder that will support the greatest load.

Terms

LOAD
SPAN
DEFLECT
WEB
FLANG
DATA
GRAPH
GAUGE
GIRDER



Objectives

As a result of this activity the student will be able to:

identify seven geometric shapes that can be used as girders.

do a flat layout, for three shapes, with one hundred percent accuracy.

construct three sheetmetal girders accurately.

test the load bearing capacity of each girder he/she constructed.

enter all data collected in a computer data base.

mathematically calculate the cost strength ratio of each girder he/she constructed.

calculate the labor cost of each girder he/she constructed.

construct a graph comparing the cost and strength of each girder he/she constructed.

Special Supplies & Equipment

1. 100 1# weights
2. PFS:GRAPH software (optional)
3. Data base software (optional)
4. Computer (optional)

Supplier

Transparency Masters & Student Handouts

GIRDER CONSTRUCTION

EQUIPMENT/SUPPLIES

1. sheet aluminum, .012 thick
2. 1/16 inch blind rivets
3. 1/4 inch drill motor
4. high speed twist drills
5. tin snips
6. sheet metal brake
7. layout tools

YOUR TIME ON TASK IS IMPORTANT. RECORD IT CAREFULLY.

PROCEDURE:

1. Select three of the geometric shapes discussed in the previous lesson.
2. On paper do a flat layout for each of these shapes that will produce a girder five centimeters long. Each web, flange, or dia. should be thirty-seven millimeters.
3. Number the bends lines in the proper sequence for folding.
4. Have each layout checked by your instructor.
5. Using the proper hand tools or machines, cut three pieces of aluminum to the exact size needed to make the three girders selected.
6. Duplicate your original layout on each of the three pieces and renumber the bends. DO NOT TRACE THE PAPER LAYOUT BECAUSE THE END PRODUCT WILL NOT BE ACCURATE ENOUGH!!
7. Have each layout checked by your instructor.
8. Using the proper tools, cut out each girder.
9. Using the proper machines and tools bend each girder to its final shape.
10. Turn the finished product in to the instructor for grading.
11. Compute the cost of each girder using the actual construction time and the hourly labor rate provided by your instructor.

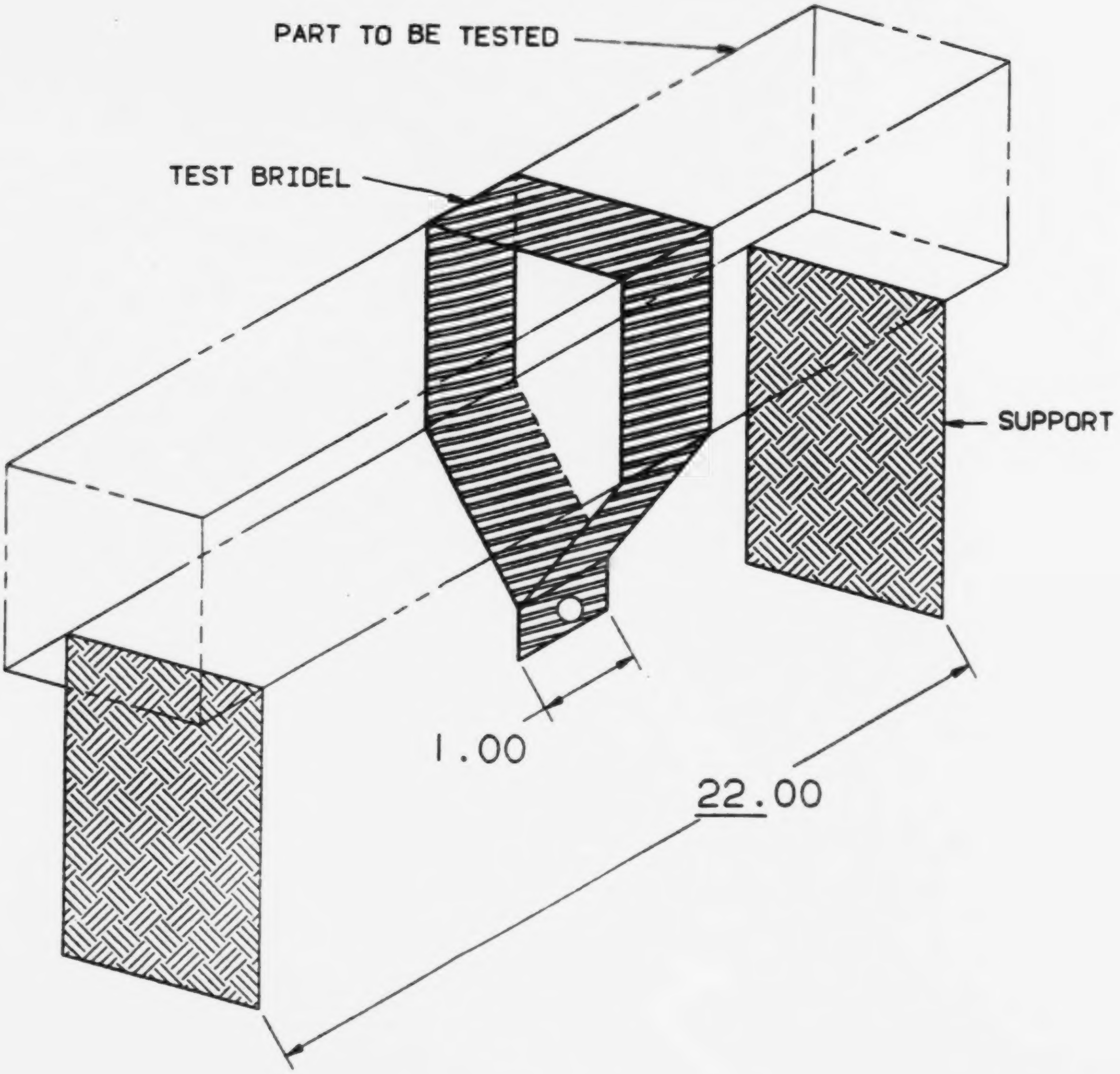
GIRDER TESTING

EQUIPMENT/SUPPLIES

100 one pound weights
1 strong container with pail handle (must hold 100 lbs.)

PROCEDURE:

1. Construct a bridle for each girder to be tested. The bridle should fit snugly and conform to the part to be tested. (see Fig. 1)
2. Place the girder on two supporting members so that the resulting span is twenty-two inches.
3. Hang a container containing twenty-one pound weights below the girder. (see Fig. 2)
4. Add weight, one pound at a time, at five second intervals, until the girder fails and falls from the supports.
5. Repeat this process with each of the other two girders.
6. Enter the test data in the computer data base if available.
7. Construct a graph showing the cost and strength relationships between the three girders.


PART TO BE TESTED
TEST BRIDEL
SUPPORT
1.00
22.00

Definition of Terms

LOAD: A mass or weight supported by something.

SPAN: Spread or distance between abutments or supports.

DEFLECT: To bend down, turn aside. To turn from a straight course or fixed direction.

WEB: A plate connecting the upper and lower flanges of a girder or rail.

FLANGE: A rib or rim for strength, for guiding, or for attachment to another object.

GIRDER: A horizontal main structural member that supports vertical loads.

GAUGE: The thickness of sheet metal or diameter of wire.

DATA: (pl of DATUM) Factual material used as a basis used for discussion or decision.

GRAPH: A diagram that represents the variation of a variable in comparison with that of one or more other variables.

Applied Math & Science Principles

MATH:

Measurement in inches and fractions

Conversion to metrics

Measurement in centimeters and millimeters

SCIENCE:

Area calculations

Ratios

Leverage

Social / Environmental Impact

Conservation of natural resources: The use of shape rather than mass to provide strength, is a direct saving in material. Indirect savings are also evident in the use of smaller, more fuel efficient equipment to handle these materials.

Conservation of human resources: The use of lighter, more efficient material has decreased the man-power needed in manufacturing and construction. This savings of human resources may have either a positive or negative impact on society.

Creative Problem Solving Activities

1. Using the data collected during this activity, construct the strongest girder possible in the shortest time.

2. Identify a problem, created by conservation of materials, that has a negative impact on society and find a solution to the problem.

3. Identify three materials, or combinations of materials, that can be used to construct girders. Do a cost/strength evaluation (all areas of cost should be included) and present the results visually.

Related Careers

Sheet metal work

Construction work

Steel work

Engineering

Woodworking

Science/Physics/Technology teacher

References

PHYSICS: White, White, Gould; Van Nostrand

Modern Metalworking: Walker; Goodheart-Willcox

Activities for Teaching Technology

Activity Title FASTENER STRENGTH TEST: METALS

Contributor CHARLES H. MEDDAUGH

Time Required 4 HRS

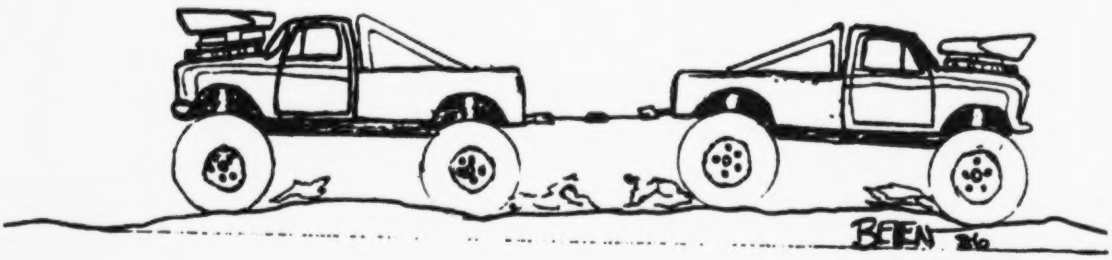
Activity Description

In this activity students will test and compare the holding power of a variety of common fastening methods for metal. Through the construction and testing of several joints, students will examine the holding power of panhead screws, rivets, blind rivets, and formed joints. Valuable hands-on experience will be gained in the use of hand tools, sheetmetal machines, and power tools. The practical application of physics and geometry will be examined during the testing.

This activity should be incorporated into a benchmetals program at a point deemed appropriate by the individual instructor. Prior to this activity the students should study the proper use of mechanical fasteners, solder, and braze.

Terms

FUSIBLE
SOLDER
MECHANICAL ADVANTAGE
FRICTION
SIMPLE MACHINE
DATA
GRAPH
FORCE
PRESSURE



Objectives

As a result of this activity the student will be able to:

install rivets in thin sheetsteel.

install blind rivets.

install panhead screws.

operate sheetmetal machines.

solder sheetmetal.

measure the amount of force required to cause three joints to fail.

enter all data collected in a computer data base.

construct a graph that compares the holding power of each fastening method chosen.

Special Supplies & Equipment	Supplier
1. Hydraulic jack with gauge	
2. Testing frame	
3. PFS:GRAPH software (optional)	
4. PFS:FILE software (optional)	
5. Computer (optional)	

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JOINT ASSEMBLY

EQUIPMENT/SUPPLIES

1. 27 gauge sheet steel
2. assorted fasteners
3. 1/4 inch drill motor
4. high speed twist drills
5. ballpeen hammer, rivet set
6. screwdriver
7. rivet gun
8 sheetmetal machines

PROCEDURE

1. READ ALL STEPS IN THIS PROCEDURE BEFORE STARING WORK.

2. Cut eight pieces of sheet steel 2" x 3".

3. Assemble the eight pieces into a test strip using seven different fastening methods. (see Fig.1)

4. Have the strip checked by your instructor before proceeding.

5. Using a lever, test the strip to see which joint fails first.

6. Repeat the lever test until all but three joints have failed.

7. Inspect the three remaining joints for damage and decide which one you think is strongest. Use this information for part two of this activity.

JOINT TEST

EQUIPMENT/SUPPLIES

1. 27 gauge sheet steel
2. Assorted fasteners
3. 1/4 inch drill motor
4. high speed twist drills
5. ballpeen hammer, rivet set
6. screwdriver
7. rivet gun
8. sheetmetal machines

YOUR TIME ON TASK IS IMPORTANT, RECORD IT CAREFULLY

PROCEDURE:

1. Cut four pieces of sheet steel 2" x 4".
2. Assemble two sheetmetal joints. (see Fig.2)
   Carefully record the time it takes to assemble each joint.
3. Calculate and record the labor cost of each joint constnucted.
4. Place each joint in the testing machine and pump the jack until the joint fails.
5. Record the pressure needed to cause each joint to fail.
6. Calculate the force needed to cause each joint to fail.
7. Using the data collected while constructing and testing your joints, develop a graph to show their cost strength relationship.
8. Enter the data collected in the computer data base if available.

MATERIAL TESTING

Developing Material Testing Equipment for Specific Needs

Ray Shackelford
David J. Schiek

Understanding the properties and characteristics of industrial materials is essential for industrial arts/technology teachers and the technological literacy of their students. Knowledge of these properties enhances the learner's understanding of the production of standard stock and the processing of materials into finished products and is essential for designing and fabricating industrial tooling and products. Thus, the study of the properties and characteristics of industrial materials has become an important element of many industrial arts/technology programs.

Typical material properties and characteristics to be investigated in an industrial materials course include mechanical, physical, chemical, acoustical, and optical. These properties and characteristics have their origins in the atomic structure of a specific material. Through testing and observation activities and experiences, the learner is encouraged to identify and describe various material properties and characteristics, such as hardness, tensile and compression strengths, grain structure, color, density, absorbancy, thermal shock, and expansion. The principles gained through such testing experiences and the understanding of a material's atomic structure can then be used in the selection and development of production processes.

Many of these tests and activities in industry and education can involve the use of expensive and sophisticated equipment. However, many material properties can be demonstrated, accurately measured, and compared using simple and relatively inexpensive equipment. In fact, learning is often enhanced when a student, group of students, or an instructor designs and builds a testing device to match specific individual or group goals and objectives.

One such testing device is shown in Figure 1. This device was designed and built by a team of students and faculty in the Department of Industry and Technology at Ball State University. The design team was guided by four broad goals during the design and fabrication of the device. They were

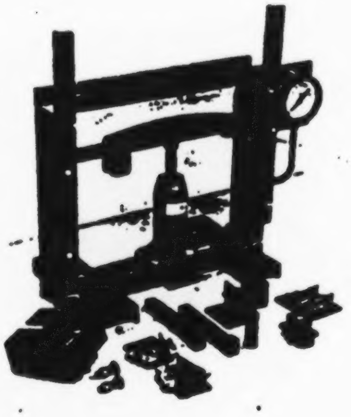

FIGURE 1
Material Tester and Select Accessories

1. to design a flexible testing device capable of supporting and encouraging both individual and course goals and objectives related to the study of industrial materials.
2. to design a testing device that could be easily fabricated and used in a junior or senior high school industrial technology facility.
3. to design a usable and comprehensive device capable of being used to perform a number of difficult tests on a variety of materials.
4. to fabricate a testing device to be as accurate and economical as possible.

The testing device, when used with the appropriate accessories, is capable of performing the following tests: tensile, hardness, mechanical fastener extraction, bend, compression, and glue line and mechanical fastener shear. Because test specimens are damaged or destroyed during these tests, the testing device is presently limited to destructive testing. Building a material tester that can be used to perform several tests on numerous materials can save money and valuable space in the laboratory because it eliminates the need for many testing devices.

DESIGN AND FABRICATION

The material tester shown in Figure 2 has six major components: (a) a *frame* of welded 4-in. channel, (b) a safety *shield*, (c) an 8-ton hydraulic *jack*, (d) a 5,000 psi pressure *gauge* (with indicator needle) and hose connection, (e) a *pivot arm* of 1 in. bar stock with ¼ in. rib, and (f) various specimen holding and/or interface *accessories* for specific individual tests (not shown). The steel channel was welded together with all flanges pointing outward. Holes were drilled in both side rails, and a slot was cut in the bottom channel for T-bolts, allowing for the attachment of the individual test specimens, interface accessories to the material tester frame, or both. The addition of the four feet gives the device the necessary support to remain upright during testing procedures. When

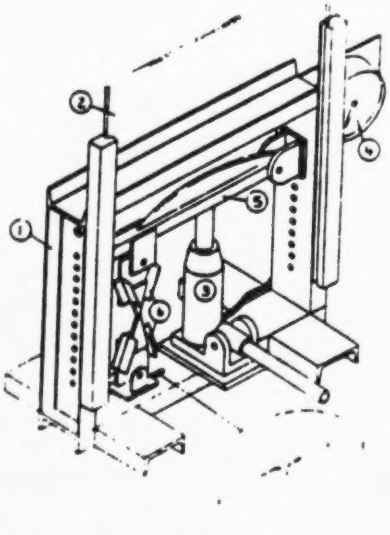

FIGURE 2
Material Tester

Ray L. Shackelford is a professor in the Department of Industry and Technology, Ball State University, Muncie, Indiana. David J. Schiek is at the Penn Yan Academy, Penn Yan, New York. This is a refereed article.

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welding equipment or trained personnel are not available, vertical side frame members can be replaced with thread rods of the appropriate size.

Mounted to both sides of the frame are side rails that support the safety shield. The rails are grooved to allow the safety shield to slide freely up and down. A stop is placed at the bottom of the grooves to accurately locate the shield during testing. A second adjustable stop is located further up the grooves to hold the shield in place during the exchange of test specimens and interface accessories. The grooves remain open at the top to facilitate the complete removal of the shield during the conversion of the material tester from one test to another.

Because of the nature of the tests, the use of the safety shield is *mandatory* and is omitted in several photographs in this article for clarity. A safety shield should also be installed on the back side of the testing device if the device is in a location where students observe or perform testing activities from both sides of the apparatus.

An 8-ton hydraulic jack was selected to provide the applied stress for the material tester. A 6-ton hydraulic jack would also be acceptable; however, care should be taken to select a jack capable of being interfaced with a load or psi gauge. Care must also be observed when selecting specimen or jack size. An improper selection of either can result in permanent damage to the material tester.

The pressure gauge selected for the material tester is a 5,000 psi gauge with indicator needle. The pressure gauge selected should have increments small enough to provide accurate readings but large enough to be easily read. The addition of the indicator needle to the gauge allows the maximum pressure or load to be recorded after the load has been reduced or removed. This tends to eliminate poor readings taken by students who must constantly watch a pressure gauge (without an indicator needle) for the point at which a specimen fails. There should also be a relationship between gauge size and specimen size so that material failure occurs around the median reading on the gauge, thereby improving test accuracy.

The material tester is designed to provide pushing and pulling action for the application of stress to test specimens. A pushing action is required for tests of compression, hardness, bend, and shear; a pulling action is required for tensile and mechanical fastener extraction tests. Because the available hydraulic jack was only a single (push) action, a device was needed to convert and transfer the single action of the hydraulic jack to a pull action.

The use of a pivot arm in conjunction with the hydraulic jack converts the pushing action of the jack to a pulling action. The pivot arm, which functions as a single class lever, divides the applied force of the hydraulic jack between the test specimen and the material tester frame. By using this simple arm, the number of tests capable of being performed with the material tester increases substantially.

Various specimen holding and/or interface accessories for the individual tests will be shown in more detail when selected individual tests are described. Accessory needs depend on the type of tests to be performed, and designs will vary according to material type and size. Care must also be taken in the design and fabrication of these accessories as to reduce any potential variabilities in the tests.

DESCRIPTION OF SELECT TESTS

A hardness test (Figure 3) can be performed to measure the resistance of a material to localized surface penetration. In this particular test, wood (a composite material) is used as the test specimen. The test results can be used (a) to determine surface hardness; (b) for comparison species studies; (c) to determine differences among radial, tangential, and cross-sectional areas; and (d) to compare surface area damage resulting from localized penetration.

The penetrator used for the hardness test of wood is a hardened steel ball. The penetrator is forced into the specimen to a depth of one-half its diameter (as determined by a friction ring), causing a permanent surface deformation in the specimen. Hardness is determined by measuring the force (stress) necessary to make the given deformation (strain). In this instance, the force (hardness) is equal to the gauge reading psi times the cross-sectional areas of the hydraulic jack piston (Force = psi × Cross-Sectional Area).

There are other types of hardness tests, such as rebound and scratch tests. These are easily simulated or replicated and are sufficient to support the teaching of the mechanical property concept of hardness.

A bend test can be used to evaluate the behavior and limits of a material or structure under bending loads. The material tester, with the addition of the necessary accessories (Figure 4) can be used to perform a flexure or bend test. By determining the load and measuring the amount of deflection, stiffness, modulus of fracture, modulus of elasticity, and ductility of a specimen or cross-sectional design can be studied. Like many other tests, the bend test can be used to determine which materials are suitable for a given application.

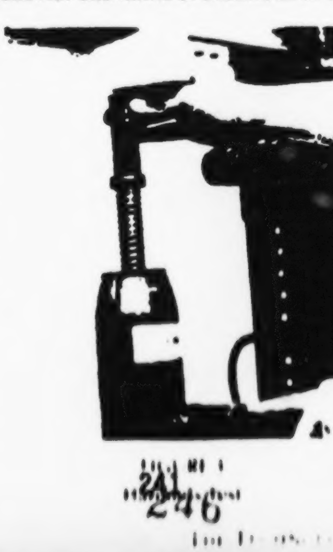

FIGURE 3
Hardness Test

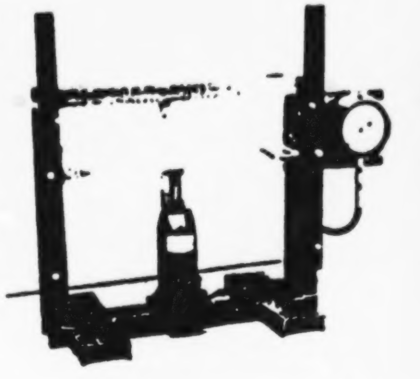

FIGURE 4
Flexure Test

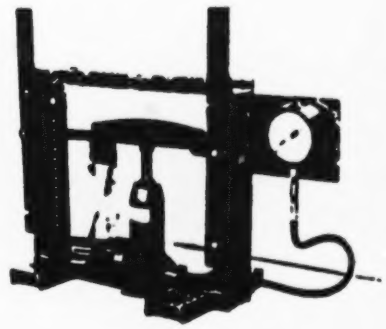

FIGURE 5
Tensile Test

Tensile strength is demonstrated by the ability of a specimen to withstand forces that tend to pull a material (or product) apart. In Figure 5, a tensile test is conducted to determine the breaking points of several different species of wood. When the hydraulic jack is placed equidistant between the frame and specimen holder pivot points, a first class lever is formed. Thus, one half of the load is supported by the frame and the other half by the specimen.

In the tensile test pictured (Figure 5), the students determine maximum load and breaking strength. Because of material tester design, the following formulas are applicable.

Maximum Load
Force (psi) = 18
(cross-sectional area of jack piston)
× 2 (1st class lever)

$$\text{Breaking Strength} = \frac{\text{Maximum Load}}{\text{Cross-Section Area (Specimen)}}$$

Other properties and characteristics observed by students in this and other tensile tests include proportional limit, yield point, ultimate strength, modulus of elasticity, ductility, elongation, and reduction of area.

Compression tests are similar to but the opposite of tensile tests. Compression strength is demonstrated by the ability of a specimen to withstand forces that tend to compress or squash a material. In a compression test, the specimen or product is compressed uniaxially until failure.

After removing the pilot arm, compression tests can be done by placing the specimen directly between the compression platen, placed on top of the hydraulic jack, and the upper support of the frame. Depending on the species and individual variations within specimens, common failures (crushing, wedge split, shearing, splitting, and a combination of shearing and splitting) can be observed when using specimens of wood. In addition, comparisons and observations can be made between the compression test and tensile test to support assumptions and decisions regarding material or product selection, standards, and applications.

The mechanical fastener extraction test (Figure 6) permits mechanical fasteners, such as nails, bolts, and screws, to be withdrawn or extracted by pulling them out of or through various base materials. The greater the load required to remove the fastener, the greater its ability to withstand the particular applied force. This test is performed by first attaching the fastener gripper to the pivot arm and the specimen holding accessory to the frame base. The specimen is slid into the holder and the gripper attached to the fastener head with a minor load. Force is then applied to the fastener until complete extraction. Maximum load is determined in the same manner as in the tensile test.

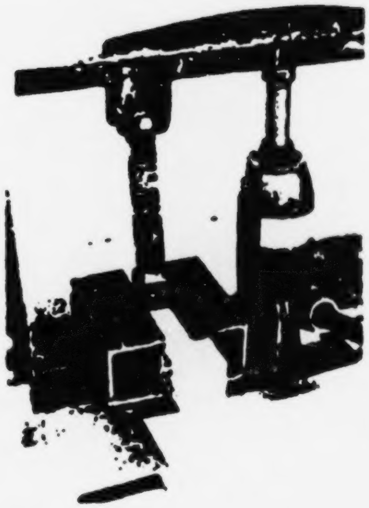

FIGURE 6
Mechanical Fastener Extraction Test

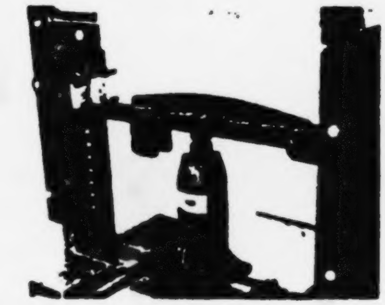

FIGURE 7
Mechanical Fastener and Adhesive Shear Test

By performing mechanical fastener extraction tests, students should be able to draw analogies and make better decisions regarding identified applications and fastener selection.

Related to the mechanical fastener extraction test is a shear test on base materials assembled with mechanical fasteners or adhesives (Figure 7). To perform a mechanical fastener or adhesive shear test, a specimen holding accessory is attached to the frame upright. Prepared specimens are slid into the holder, the pivot arm is placed in position, and a minor load is applied. To maintain a first class lever, the jack must be placed equidistant between the shear point and the frame pivot point. The major load is then applied until fracture occurs, at which point readings are taken to be used in the determination of maximum load for mechanical fastener shear results and breaking strength for the adhesive shear test.

Standards and Guidelines for Undergraduate Program Evaluation in Industrial Arts Teacher Education*

and

Standards and Guidelines for Graduate Degree Programs in Industrial Arts Teacher Education*

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CONCLUSION

The study of the properties and characteristics of industrial materials is essential for industrial arts/technology teachers and the technological literacy of all students. The design and fabrication of testing equipment by students and teachers can provide equipment and experiences that specifically match identified goals and objectives and can increase understanding through the application of knowledge and broader concepts to the problem under investigation. The material tester described in this article is only one example of many devices that can be built very simply to simulate or replicate industrial material tests.

One final note on the accuracy of this particular testing device: Many of the tests described herein are commonly conducted on what is referred to as a universal testing machine. To test the reliability of the material tester, samples were prepared for five different tests. One half of the samples were tested using a universal testing machine, and the other half were tested on the student machine. Allowing for test variables, there appeared to be no significant difference in the test results. However, one of the major differences was cost. By scrounging and using scrap materials whenever possible, the material tester was fabricated at a cost of $75.00. The universal testing machine and attachments were purchased for approximately $15,000. Naturally, a few pieces of scrap channel, a hydraulic jack, and a gauge cannot replace the validity and reliability of a universal testing machine, but when the course objectives are to demonstrate the concepts of material properties and characteristics and to compare common materials, then student- and teacher-built equipment becomes a workable alternative.

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Definition of Terms

FUSABLE: To mix together by melting.

SOLDERING: Joining together with a nonferrous filler without melting the base metal.

MACHINE: Any device that transmits the application of a force into useful work.

FORCE: Strength; power. The exertion of such power.

PRESSURE: Force applied over a surface measured as force per unit of area.

MECHANICAL ADVANTAGE: The ratio of the output force of a machine to the input force.

FRICTION: The rubbing of one object on another.

DATA: (pl of DATUM) Factual material used as a basis used for discussion or decision making.

GRAPH: A diagram that represents the variation of a variable in comparison with that of one or more other variables.

Applied Math & Science Principles

MATH:

Measurement in inches and fractions

SCIENCE:

force
friction
cohesion
adhesion
pressure

Social/Environmental Impact

Creative Problem Solving Activities

1. Using the data collected during this activity, select and construct the lap joint that you think has the greatest strength to cost ratio and test your results.

Related Careers

Carpenter

Construction work

Cabinet maker

Engineering

Patternmaker

Science/Physics/Technology teacher

References

PHYSICS: White, White, Gould; Van Nostrand

Modern Metalworking;

Activities for Teaching Technology

Activity Title FASTENERS STRENGTH TEST: WOOD

Contributor CHARLES H. MEDDAUGH

Time Required 4 HRS

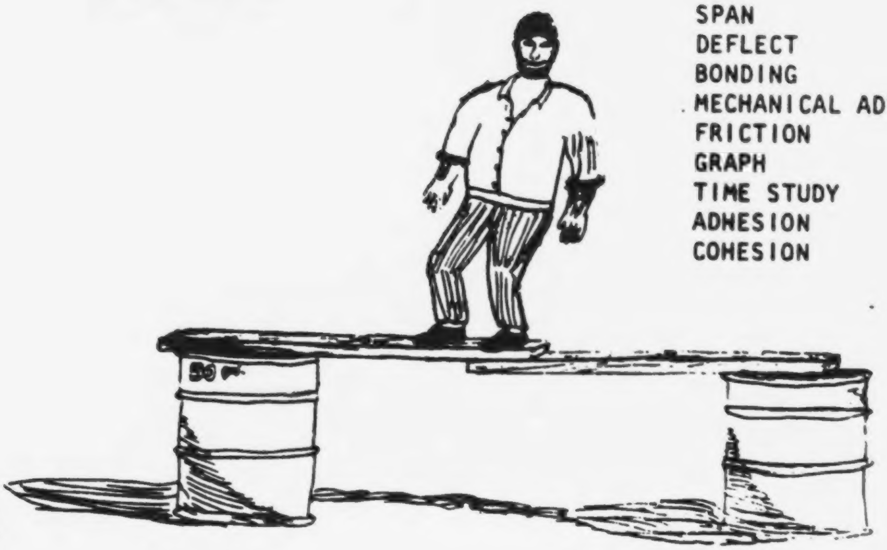
Activity Description

In this activity students will test and compare the load bearing capacity of a variety of common fasteners used in wood. Through the construction and testing of several lap joints, students will examine the holding power of woodscrews, nails, and glue. Valuable hands-on experience in the use of hand tools, woodworking machines, and power tools will be gained and the practical application of physics and geometry will be examined during the testing.

This activity should be incorporated into a woodworking program at a point deemed appropriate by the individual instructor. As part of, or prior to this activity the students must study the proper use of nails, woodscrews, and glues.

Terms

LOAD
SPAN
DEFLECT
BONDING
MECHANICAL ADVANTAGE
FRICTION
GRAPH
TIME STUDY
ADHESION
COHESION



Objectives

As a result of this activity the students will be able to:

cut wood to size accurately.

properly install woodscrews.

assemble lap joints.

measure the amount of force required to cause a lap joint to fail.

enter all data collected in a computer data base.

mathematically calculate the cost strength ratio of each joint constructed.

construct a graph comparing the costs and strengths of each joint he/she constructed.

Special Supplies & Equipment

1. Hydraulic jack with gauge
2. Testing frame
3. PFS:GRAPH software (optional)
4. PFS:FILE software (optional)
5. Computer (optional)

Supplier

Transparency Masters
&
Student Handouts

FASTENERS FOR WOOD

There are many ways to fasten wood products together. Nails are available in many shapes and sizes but they may not always have enough holding power. Woodscrews produce a stronger joint but take longer to install properly. Glue is easy and quick to use but may fail under some conditions. Each fastening method has both advantages and disadvantages. At times it can be useful to combine two or more methods to overcome some problems, but as production time increases the cost of construction rises.

The goal of this exercise is to compare the strengths of a variety of fasteners and combinations of fasteners. To do this you will assemble three lap joints and test their holding power. Your instructor will tell you which fastening method to use. Each joint should be constructed as carefully as possible. The second page of this handout shows the proper layout for each joint. Follow it carefully and remember to record your construction time.

JOINT CONSTRUCTION

EQUIPMENT/SUPPLIES

1. 1 x 3 x 40" pine
2. assorted fasteners
3. 1/4 inch drill motor
4. high speed twist drills
5. hammer
6. screw driver
7. glue

YOUR TIME ON TASK IS IMPORTANT, RECORD IT CAREFULLY

PROCEDURE:

1. Assemble each of the three lap joints assigned by your instructor. Carefully record the time it takes to assemble each joint, to the nearest tenth of an hour.

2. Calculate and record the labor cost of each lap joint constructed.

3. Place each lap joint in the testing frame and pump the jack until either the joint fails or the wood breaks. NOTE: The joint has failed when it deflects.

4. Record the pressure needed to cause each joint to fail.

5. Calculate the force needed to cause each joint to fail.

6. Using the data collected while constructing and testing your lap joints, develop a graph to show their cost strength relationship.

7. Enter the data collected in the computer data base if available.

Developing Material Testing Equipment for Specific Needs

Ray Shackelford
David J. Schiek

Understanding the properties and characteristics of industrial materials is essential for industrial arts/technology teachers and the technological literacy of their students. Knowledge of these properties enhances the learner's understanding of the production of standard stock and the processing of materials into finished products and is essential for designing and fabricating industrial tooling and products. Thus, the study of the properties and characteristics of industrial materials has become an important element of many industrial arts/technology programs.

Typical material properties and characteristics to be investigated in an industrial materials course include mechanical, physical, chemical, acoustical, and optical. These properties and characteristics have their origins in the atomic structure of a specific material. Through testing and observation activities and experiences, the learner is encouraged to identify and describe various material properties and characteristics, such as hardness, tensile and compression strengths, grain structure, color, density, absorbancy, thermal shock, and expansion. The principles gained through such testing experiences and the understanding of a material's atomic structure can then be used in the selection and development of production processes.

Many of these tests and activities in industry and education can involve the use of expensive and sophisticated equipment. However, many material properties can be demonstrated, accurately measured, and compared using simple and relatively inexpensive equipment. In fact, learning is often enhanced when a student, group of students, or an instructor designs and builds a testing device to match specific individual or group goals and objectives.

One such testing device is shown in Figure 1. This device was designed and built by a team of students and faculty in the Department of Industry and Technology at Ball State University. The design team was guided by four broad goals during the design and fabrication of the device. They were

1. to design a flexible testing device capable of supporting and encouraging both individual and course goals and objectives related to the study of industrial materials.
2. to design a testing device that could be easily fabricated and used in a junior or senior high school industrial technology facility.
3. to design a usable and comprehensive device capable of being used to perform a number of difficult tests on a variety of materials.
4. to fabricate a testing device to be as accurate and economical as possible.

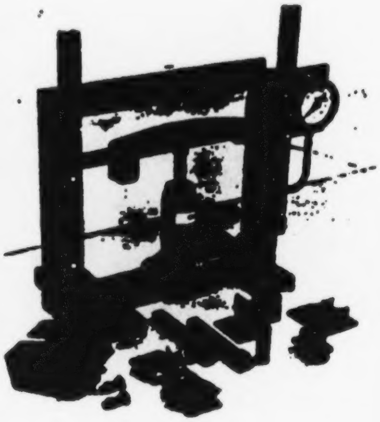


FIGURE 1
Material Tester and Select Accessories

The testing device, when used with the appropriate accessories, is capable of performing the following tests: tensile, hardness, mechanical fastener extraction, bend, compression, and glue line and mechanical fastener shear. Because test specimens are damaged or destroyed during these tests, the testing device is presently limited to destructive testing. Building a material tester that can be used to perform several tests on numerous materials can save money and valuable space in the laboratory because it eliminates the need for many testing devices.

DESIGN AND FABRICATION

The material tester shown in Figure 2 has six major components: (a) a *frame* of welded 4-in. channel, (b) a safety *shield*, (c) an 8-ton hydraulic *jack*, (d) a 5,000 psi pressure *gauge* (with indicator needle) and hose connection, (e) a *pivot arm* of 1 in. bar stock with ½ in. rib, and (f) various specimen holding and/or interface *accessories* for specific individual tests (not shown). The steel channel was welded together with all flanges pointing outward. Holes were drilled in both side rails, and a slot was cut in the bottom channel for T-bolts, allowing for the attachment of the individual test specimens, interface accessories to the material tester frame, or both. The addition of the four feet gives the device the necessary support to remain upright during testing procedures. When

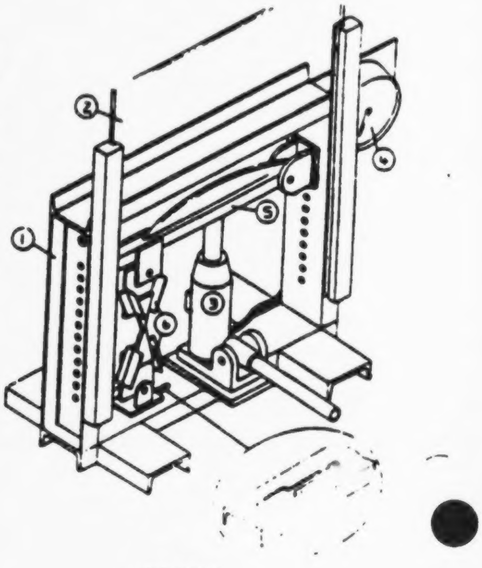


FIGURE 2
Material Tester

Ray L. Shackelford is a professor in the Department of Industry and Technology, Ball State University, Muncie, Indiana. David J. Schiek is at the Penn Yan Academy, Penn Yan, New York. This is a refereed article.

welding equipment or trained personnel are not available, vertical side frame members can be replaced with thread rods of the appropriate size.

Mounted to both sides of the frame are side rails that support the safety shield. The rails are grooved to allow the safety shield to slide freely up and down. A stop is placed at the bottom of the grooves to accurately locate the shield during testing. A second adjustable stop is located further up the grooves to hold the shield in place during the exchange of test specimens and interface accessories. The grooves remain open at the top to facilitate the complete removal of the shield during the conversion of the material tester from one test to another.

Because of the nature of the tests, the use of the safety shield is *mandatory* and is omitted in several photographs in this article for clarity. A safety shield should also be installed on the back side of the testing device if the device is in a location where students observe or perform testing activities from both sides of the apparatus.

An 8-ton hydraulic jack was selected to provide the applied stress for the material tester. A 6-ton hydraulic jack would also be acceptable; however, care should be taken to select a jack capable of being interfaced with a load or psi gauge. Care must also be observed when selecting specimen or jack size. An improper selection of either can result in permanent damage to the material tester.

The pressure gauge selected for the material tester is a 5,000 psi gauge with indicator needle. The pressure gauge selected should have increments small enough to provide accurate readings but large enough to be easily read. The addition of the indicator needle to the gauge allows the maximum pressure or load to be recorded after the load has been reduced or removed. This tends to eliminate poor readings taken by students who must constantly watch a pressure gauge (without an indicator needle) for the point at which a specimen fails. There should also be a relationship between gauge size and specimen size so that material failure occurs around the median reading on the gauge, thereby improving test accuracy.

The material tester is designed to provide pushing and pulling action for the application of stress to test specimens. A pushing action is required for tests of compression, hardness, bend, and shear; a pulling action is required for tensile and mechanical fastener extraction tests. Because the available hydraulic jack was only a single (push) action, a device was needed to convert and transfer the single action of the hydraulic jack to a pull action.

The use of a pivot arm in conjunction with the hydraulic jack converts the pushing action of the jack to a pulling action. The pivot arm, which functions as a single class lever, divides the applied force of the hydraulic jack between the test specimen and the material tester frame. By using this simple arm, the number of tests capable of being performed with the material tester increases substantially.

Various specimen holding and/or interface accessories for the individual tests will be shown in more detail when selected individual tests are described. Accessory needs depend on the type of tests to be performed, and designs will vary according to material type and size. Care must also be taken in the design and fabrication of these accessories as to reduce any potential variabilities in the tests.

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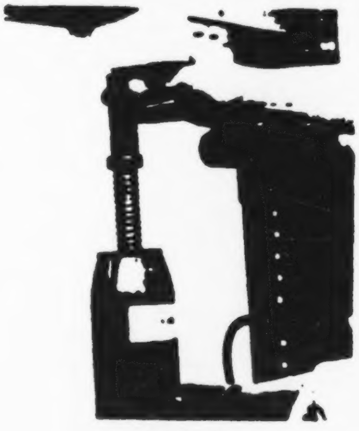

FIGURE 3

Hardness Test

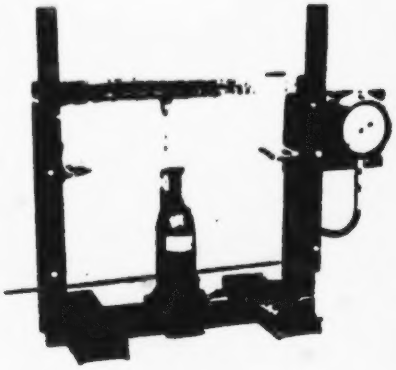

FIGURE 4

Flexure Test

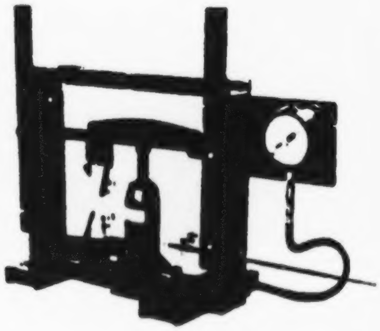

FIGURE 5

Tensile Test

Tensile strength is demonstrated by the ability of a specimen to withstand forces that tend to pull a material (or product) apart. In Figure 5, a tensile test is conducted to determine the breaking points of several different species of wood. When the hydraulic jack is placed equidistant between the frame and specimen holder pivot points, a first class lever is formed. Thus, one half of the load is supported by the frame and the other half by the specimen.

In the tensile test pictured (Figure 5), the students determine maximum load and breaking strength. Because of material tester design, the following formulas are applicable:

$$\text{Maximum Load} = \frac{\text{Force (psi)} \times 18 \text{ (cross-sectional area of jack piston)}}{2 \text{ (1st class lever)}}$$

$$\text{Breaking Strength} = \frac{\text{Maximum Load}}{\text{Cross-Section Area (Specimen)}}$$

Other properties and characteristics observed by students in this and other tensile tests include proportional limit, yield point, ultimate strength, modulus of elasticity, ductility, elongation, and reduction of area.

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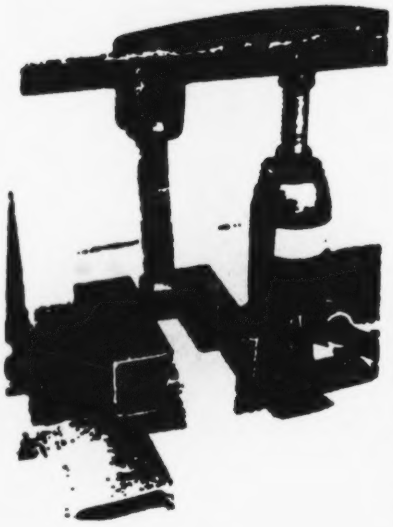
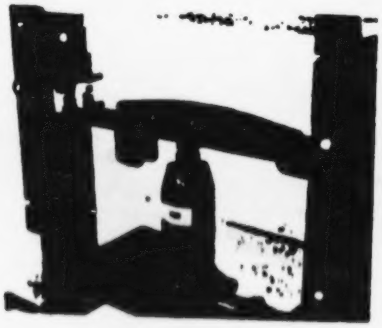


FIGURE 6
Mechanical Fastener Extraction Test



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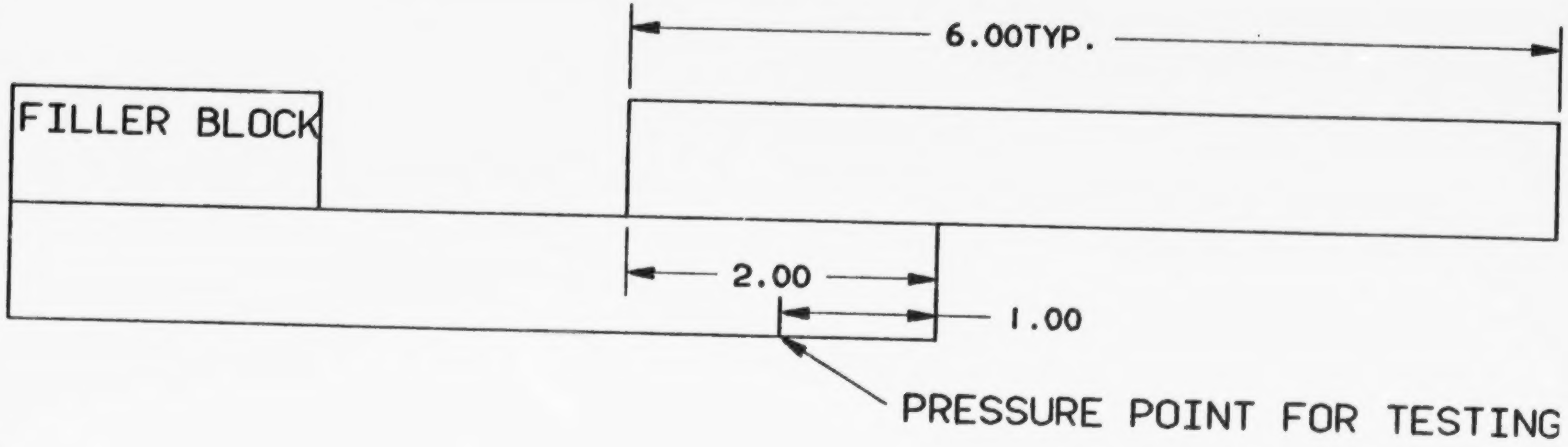
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FILLER BLOCK
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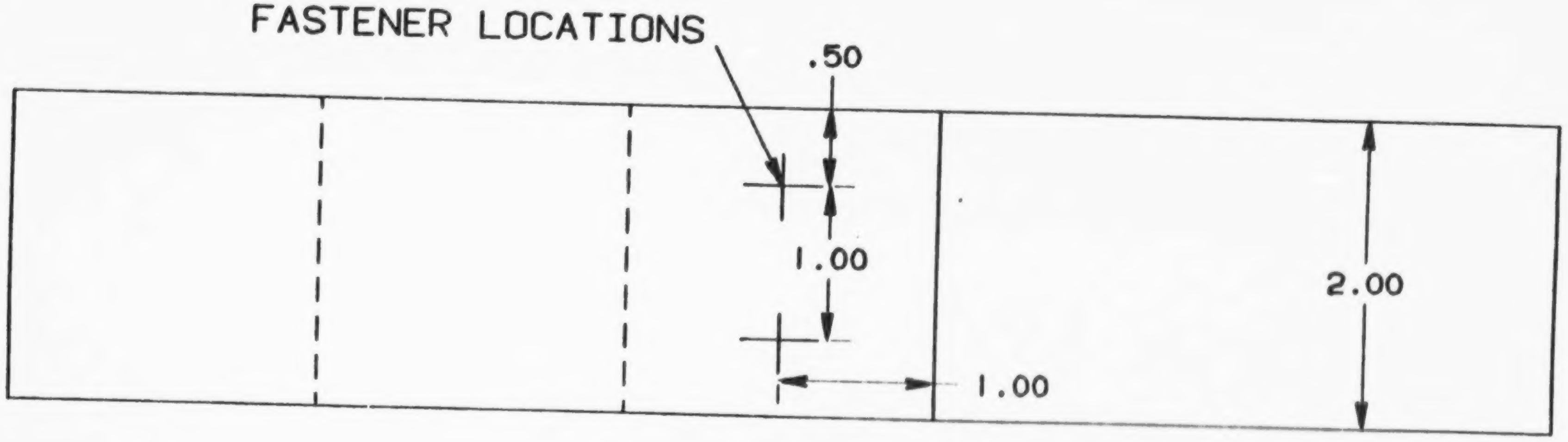
PRESSURE POINT FOR TESTING


FASTENER LOCATIONS
.50
1.00
2.00
1.00

Definition of Terms

COHESION: Attractive force between two molecules of the same substance.

ADHESION: Attractive force between molecules of different substances.

DEFLECT: To bend down, turn aside. To turn from a straight course or fixed direction.

FORCE: Strength; power. The exertion of such power.

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Social / Environmental Impact

Creative Problem Solving Activities

1. Using the data collected during this activity, select and construct the lap joint that you think has the greatest strength to cost ratio and test your results.

2. Identify as many environmental factors as possible, that could affect the outcome of this activity. Select the most common one and decide how to best control it.

3. Identify as many different types of glue as possible and compare their holding power.

Related Careers

- Carpenter
- Construction work
- Cabinet maker
- Engineering
- Patternmaker
- Science/Physics/Technology teacher

References

PHYSICS: White, White, Gould; Van Nostrand

Advanced Woodworking: Hutchings; Goodheart-Willcox

MANUFACTURING

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Activities for Teaching Technology

Activity Title PRODUCTARIANS

Contributor CHUCK GOSDZINSKI

Time Required 1 SEMESTER

Activity Description

The goals of productarians are to design, to develop and mass produce a product. The design and production planning stages are to be completed prior to the final competition at the end of the semester. During the final competition each team will produce 15 identical products. There should be 5-6 students on each team. The idea behind the activity is to develop a product, to develop a procedure to produce the product, and to package the product.

Terms

- COST OVERRUN
- FLOW CHART
- INVENTORY
- MATERIAL HANDLING
- PACKAGING
- PRODUCT DESIGN
- PRODUCTION ENGINEERS
- PRODUCTIVITY
- QUALITY CONTROL
- RESEARCH AND DEVELOPMENT
- RETOOLING
- SYSTEMS PLANNING
- WORK MEASUREMENT
- WORK STATION

JLHS
JLHS
JLHS

Objectives

As a result of their learning experience, students will:

Design, redesign or duplicate an existing product.

Develop a prototype of a desired product.

Develop jigs and fixtures to produce the product.

Develop a system to produce a product.

Design a package to contain a product.

Understand how to use the tolls of the lab safely and efficiently.

Special Supplies & Equipment

Supplier

Transparency Masters
&
Student Handouts

LIMITATIONS

1. Assembly tools/equipment/conveyor belts, etc. may be placed directly in the assembly area. They must stay within the boundary areas of the assembly area, the warehouse and the shipping dock. The boundary areas will be defined by tape with an imaginary wall extending upward.

2. Commercial items, standard parts, motors, brackets, fasteners, adhesives, fabrics, papers, etc. are allowed.

3. During the assembly process hand tools and electric drills may be used.

4. Electricity and electric motors are permitted to be used in the production line.

5. Safety glasses must be worn in any operation involved in removing hard material, i.e. drilling holes, cutting wood, cutting metal, etc.

6. The finished products may be of any type, but must be user ready and must work.

7. The time limit for style, set-up, and problem competition is 30 minutes.

8. The cost (including all 10 products) is not to exceed $75.00. Equipment and tools used to produce the product do not count toward costs. Additional points will be given for the product with the least expensive components. Under $20.00 = +15 points; under $40.00 = +10 points; under $60.00 = +5 points. This is the judge's decision. However, teams should have available copies of any receipts which they have. Costs for the style presentation do not count.

9. No cost limits are placed on the 15 packages for the produced items.

10. Each team member must complete and give to the instructor a copy of a completed master bill of materials.

11. Fasteners such as adhesives, pins, nails, screws, nut/washer/bolt assemblies, tape, velcro, etc., will not be considered parts.

12. Parts of the product may be pre-assembled or prepared prior to the competition. A pre-assembled or prepared part will count as only one part in scoring the number of parts.

SCORING

1. The production line
   a. How the materials are transported through the production facility.
      1. passed by hand. . . . .(1 to 05 points)
      2. passed by hand with minimal mechanical assistance, i.e. dolly. . . . .(1 to 10 points)
      3. system, i.e. conveyor belt, vacuum tube, etc. . . .(1 to 15 points)
      4. sophisticated, i.e. items not touched (except for assembly) from warehouse to shipping dock (turning a crank or wheel by hand which moves a conveyor belt is considered sophisticated) . . . .(1 to 25 points)

Possible 25 points

2. The product's design
   a. Duplicating an existing product . . . .(1 to 5 points)
   b. Redesigning an existing product . . . .(1 to 15 points)
   c. Designing an entirely new product . . . .(1 to 25 points)

Possible 25 points

3. Product Complexity
   a. The number of separate parts which contribute to the function of the product, i.e. 4 wheels equal 4 parts (1 point each part, maximum of 10 points) . . . .(1 to 10 points)
   b. The number of different types of materials used, (broad categories, i.e. wood--not pine, oak, mahogany--glue; plastic; metal; etc.) Each material used receives 2 points, maximum 10 points. . . . .(2 to 10 points)
   c. The modification by the team of materials or the use of team made parts, i.e. bending metal, folding paper, cutting . . . .(1 to 10 points)

Possible 30 points

4. Cost consideration. . . . . 0 to 15 points

5. The design of the package . . . . 1 to 20 points

6. Each completed, packaged item placed in the shipping dock (10 items x 5 points) . . . . 0 to 75 points

TOTAL 200 points

PENALTIES

1. Missing/incomplete cost analysis sheet. . . . . -1 to -50 points
2. Exceeding the cost limit. . . . . -5 to -100 points
3. Unsportsmanlike conduct @ offense . . . . -25 points
4. Outside assistance. -5 to -100 points
5. Damage to the premises. . . . . -5 to -100 points
6. Leaving a messy competition area. . . . . -5 to -100 points

Definition of Terms

COST OVERRUN: Exceeding expected cost of product due to poor materials or manufacturing.

FLOW CHART: A diagram that outlines the steps in making and assembling the parts.

INVENTORY: List of materials on hand.

PRODUCTIVITY: How fast and accurately products are made.

QUALITY CONTROL: Making sure products made in a factory meet certain standards. Prevents defective articles from being produced.

RESEARCH AND DEVELOPMENT: Processes used to find new ideas and develop them into successful products.

RETOOLING: Changing jig, fixtures, templates or machines.

SYSTEMS PLANNING: Production engineers designing the layout of a production facility.

WORK MEASUREMENT: Determining the amount of time to complete a task.

WORK STATION: Place where a specific activity is performed in the manufacturing of a product.

Applied Math & Science Principles

Math and algebra principles are reinforced through calculation of materials. Time and work principles are introduced.

Social / Environmental Impact

Only recently have we begun to worry about our tremendous trade deficit. It appears American quality and productivity are no longer at the forefront of the world economy. Many labor jobs in our country have been lost due to the fact that we must increase quality and production.

Japan appears to have the answer to this question. Many American industries have begun to create productions systems similar to Japan's.

Creative Problem Solving Activities

Brain storming during product design unit:

1. Product choice.
2. Material choice.
3. Materials handling procedure.

Have students design a package for the intended product.

Related Careers

Robotics Technician

Production Coordinator

Manufacturers Representative

Electrical and Electronics Engineer

Industrial Engineer

Manufacturing Engineer

Computer Service Technician

Industrial Traffic Manager

Laser Technician

Assembly Line Worker

Metal Cutting Machine Operator

Manufacturing Inspector

Manufacturing Painter

Machinist

Mold Maker and Coremaker

Millweight

Pattern Maker and Modelmaker

Production Welder

Data Entry Equipment Operator

Payroll Clerk

Shipping and Receiving Clerk

Chemical Technician

Numerical Control Tool Operator

References

Fates, Sheets, Mervich, Dinan; "Manufacturing," 1980, McKnight. Publ. Co.

Fierer, Lindbeck; "Production Technology," 1984, Bennett and McKnight Publ. Co.

Wright, Jensen; "Manufacturing," 1976, Goodheart - Wilcox.

Micklas, Sam. OM, Technocrats.

Activities for Teaching Technology

Activity Title HAVE FUN WITH ROBOTICS

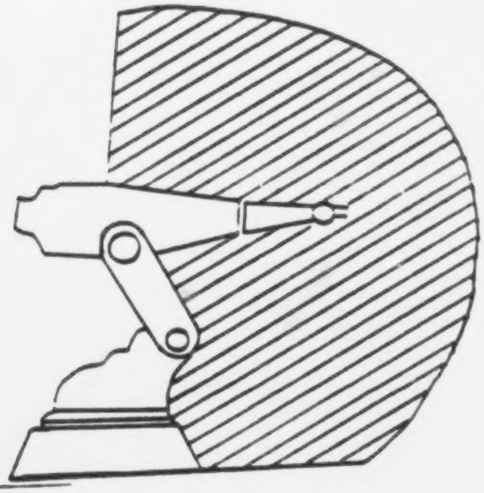
Contributor ED BALL

Time Required 4 WEEKS (20 HOURS)

Activity Description Robots play a key role in the technological advancement of industry in the future. The students will discuss many practical uses of robots in many areas of technology and study manufacturing techniques through constructing a robot and setting up a corporation.

Terms

ANDROID
AUTOMATION
AXIS
COMPONENT PACKAGING
CONTROLLER
CUSTOM-MADE
INDUSTRIAL ROBOT
MASS PRODUCTION
REPROGRAMMABLE
ROBOT
WORK ENVELOPE



Objectives

To become acquainted with history of robots.

To study the development of the robotics field.

To appropriately define what is a robot and what is not a robot.

To explore socio-economical factors of robotics.

To become acquainted with the manufacturing industry.

To study the corporate structure.

To construct a working model of an industrial robot.

To understand robot applications.

Special Supplies & Equipment	Supplier
1. Miscellaneous supplies of boxes, pipe cleaners, cans, caps, etc.	
2. ARMATRON	MAN 1

Transparency Masters
&
Student Handouts

ROBOTICS PROJECT

MATERIALS:

1. Miscellaneous cardboard, tubes, boxes, cans, cups, etc.
2. Miscellaneous T.V. and radio knobs, old electronic toy pieces, etc.
3. Glue, tape, scissors, etc.

Follow these steps to construct your robot and set up your corporations:

1. Divide students into groups to establish corporations. Best to have no more than six and as few as one. One is tough, so don't encourage it.

2. The corporation must come up with and develop a: professional folder, company name, company motto, company logo, business card, and president, vice-president, etc.

3. After viewing examples of robots in industry (slides, video, movie, research) give each student a couple of blank sheets of paper and have them sketch the robot they feel their corporation should develop.

4. Then have a corporate meeting where each individual tries to sell his/her idea to the corporation.

5. After the corporation decides on an idea, they set out to make a prototype of their corporate product.

6. Their professional corporate folder will contain their: business cards, company logo, all the robot sketches, work duties (who did what), work envelope details, simulated price list for their robot, and everything relating to the corporation.

7. Rules governing robots include that the robot must have:
   a. at least three moving axes (usually hip, shoulder, elbow).
   b. an endeffector for at least one "stated" industrial application (welding, lift, etc.)
   c. logo must appear on robot.
   d. its programming components must be a part of the robots base or along side it, connected by wiring or cables.
   e. a small p.r. sign must be attached to the base describing what industrial applications this robot is capable of doing.

Definition of Terms

ANDROID: A robot which is made to look human or has some human resemblance.

AUTOMATION: The technique of making a process, usually in manufacturing, automatic, self-moving, or self-controlling.

AXIS: A basic motion or plane of travel.

COMPONENT PACKAGING: The way the controller, programming equipment and power supply are placed in the robot system; either integrated components (a part of the robot itself) or separate components interfaced to the robot by cables.

CONTROLLER: The "brain" of the robot, used to direct motion, store program data and interface with other equipment.

CUSTOM-MADE: Made to order, according to the customer's specifications.

INDUSTRIAL ROBOT: Robots that gear their efforts towards the application of industrial tasks; like welding, lifting, painting, etc.

MASS PRODUCTION: The production of parts on an uninterrupted, large scale.

REPROGRAMMABLE: Capable of having operational instructions changed as the tasks of the robot change.

ROBOT: A reprogrammable multifunctional manipulator, designed to move materials, parts, tools or specialized devices through variable programmed motions for the performance of a variety of tasks.

WORK ENVELOPE: The total space reached by the robot arm during its operation; the maximum reach of the robot in all directions.

Applied Math & Science Principles

Principles of Electrical, Pneumatic and Hydraulic Systems

- advantages/disadvantages

Social / Environmental Impact

1. Discuss the impacts of a total factory run by robots with very little human intervention.
2. Discuss what type of jobs robots are best suited for.
3. Discuss safety systems robots are using to keep people from getting hurt.
4. Discuss in detail the pros and cons of robotics and how they will definitely effect your students job market of the future.
5. Have a class debate on the pros and cons of robots in society.

Creative Problem Solving Activities

1. Add more axis to your robot to make it more functional.
2. Add replaceable endeffectors to make your robot more marketable.
3. With an armatron, do simulations of industrial applications.
4. With an armatron, do programmer simulations by keeping track and recording all the moves it takes you to do one process (move a ball). Make sure you count each move of an axis as one move!
5. Have a robot competition, with all your kids in the cafeteria, with armatron activities from your lab to see who's the best in your class.
6. Go visit a factory or community college that has a robotics facility.

Related Careers

Production Worker

Mechanic

Programmer

Technician

Supervisor

Production Engineer

Manufacturing Engineer

Hydraulic Engineer

Pneumatic Engineer

Electrical Engineer

Robot Distributer

ROBOT:

Engineer

Salesperson

Scientist

Trainer

Industrial Technician

Designer

References

Michigan Industrial Arts Curriculum, "Robotics", 1984.

Robotics Explained. BBC. 1985 Bergwall Productions, Inc., Box 238, Garden City, NY 11530.

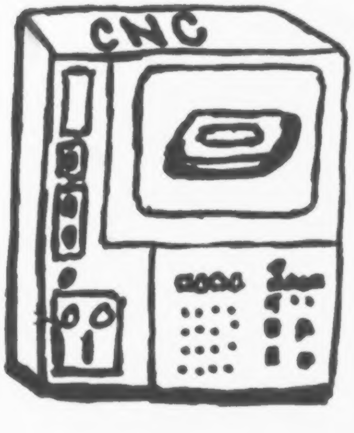
Robotics Balletique - 16mm film, your WISD

Activities for Teaching Technology

Activity Title	PROGRAMMING CNC MACHINES
Contributor	LEE SCHAUDE
Time Required	3 DAYS
Activity Description	Students will learn to write sample Electrical Industries Association manual programs using standard G&M codes.

Terms

CARTISIAN COORDINATES
CIRCULAR INTERPULATION
CNC
FEED
G-CODE
HOME POSITION
LINEAR INTERPULATION
M-CODE
NC
PECK CYCLE
RAPID TRANSVERSE
TOOL OFFSET
WORK PIECE COORDINATES
X-AXIS
Y-AXIS
Z-AXIS



Objectives

The student should be able to:

Describe the elements of an NC part program.

Define the meaning of the categories of code.

Explain the general process for developing an NC program from a part sketch to the production of a finished part.

Develop a simple part program from instructor provided requirements.

Special Supplies & Equipment | Supplier

Paper

- -lined
- -grid

Transparency Masters
&
Student Handouts

INTRODUCTION

We are going to study the basic rules for developing NC programs on lathes and vertical mills using absolute positioning and artisian coordinates. We will define the elements of the part program, categories of code, and general programming rules.

The method for developing a part program begins with a sketch of the part and then writing and editing of the program.

Numerical control (NC) programming consists of a sequence of instructions written in a format that can be read and executed by a CNC machine tool. The programs you will learn to write will meet the format requirements of EIA (Electrical Industries Association standard RS-274D.) This format is similar to that employed on larger NC machines found in industry.

MANUAL PROGRAMMING

G-Codes are used to tell a machine tool some preparatory information such as: type of motion, type of cycle, tool offset, and etc.

Here is a list of some commonly used G-Codes:

G00 - Rapid traverse
G01 - Linear interpolation (straight cut)
G02 - Arc (Circular interpolated cut) clockwise
G03 - Arc (Circular interpolation) counter-clockwise
G40 - Tool offset cancel
G41 - Tool offset - left
G42 - Tool offset - right
G54 - Work piece coordinates
G83 - Peck Drill cycle

M-Codes are miscellaneous functions. These are used to give the machine special instructions such as: tool change, spindle on and off, coolant on and off, and etc.

M02 - End of Program
M03 - Spindle on clockwise
M05 - Spindle stop
M06 - Tool Change
M08 - Coolant on
M09 - Coolant off

The M06 command is used for a tool change. We must also use a T with a number to tell the machine which tool to select. For example: M06 T1 - tells the machine to go and pick up tool 1.

We must also use a feed rate so the machine knows how fast to move. The feed is specified with a F and a number. For example: F10.00 would be a feedrate of 10 inches per minute.

We must be able to change spindle speed also. We use an S with a number. For example: S800 would be a spindle rpm of 800.

Positions in CNC programming are given in cartesian coordinates. (X, Y, Z.)

Here are a few examples of G-Code programming.

```
N005 G01 X 1.000 Y2.0000 F8.00
```

This is sequence number 5. The G code tells the machine to make a linear move. The machine is told to move to a point whose coordinates are X1 and Y2 at a feedrate of 8 inches per minute. (Note: all examples in this lesson use absolute programming.)

```
N210 G02 X1 Y0 I0 J0 R1 F6.00
```

This is sequence 210. The G02 tells the machine to make a clockwise circular move. The X and Y are the endpoints of the move. The I and J are the center point coordinates of the arc. (The I is the X coordinate, the J is the Y coordinate of the center of the arc.) The R tells the machine to mill a 1" radius. G03 is the same except it is a CCW move.

G41 D.500 tells the machine to offset the cutter to the left .500. This is used to offset the program for different size cutters and to adjust piece size. G42 is the same except that it offsets to the right. G40 cancels the offset.

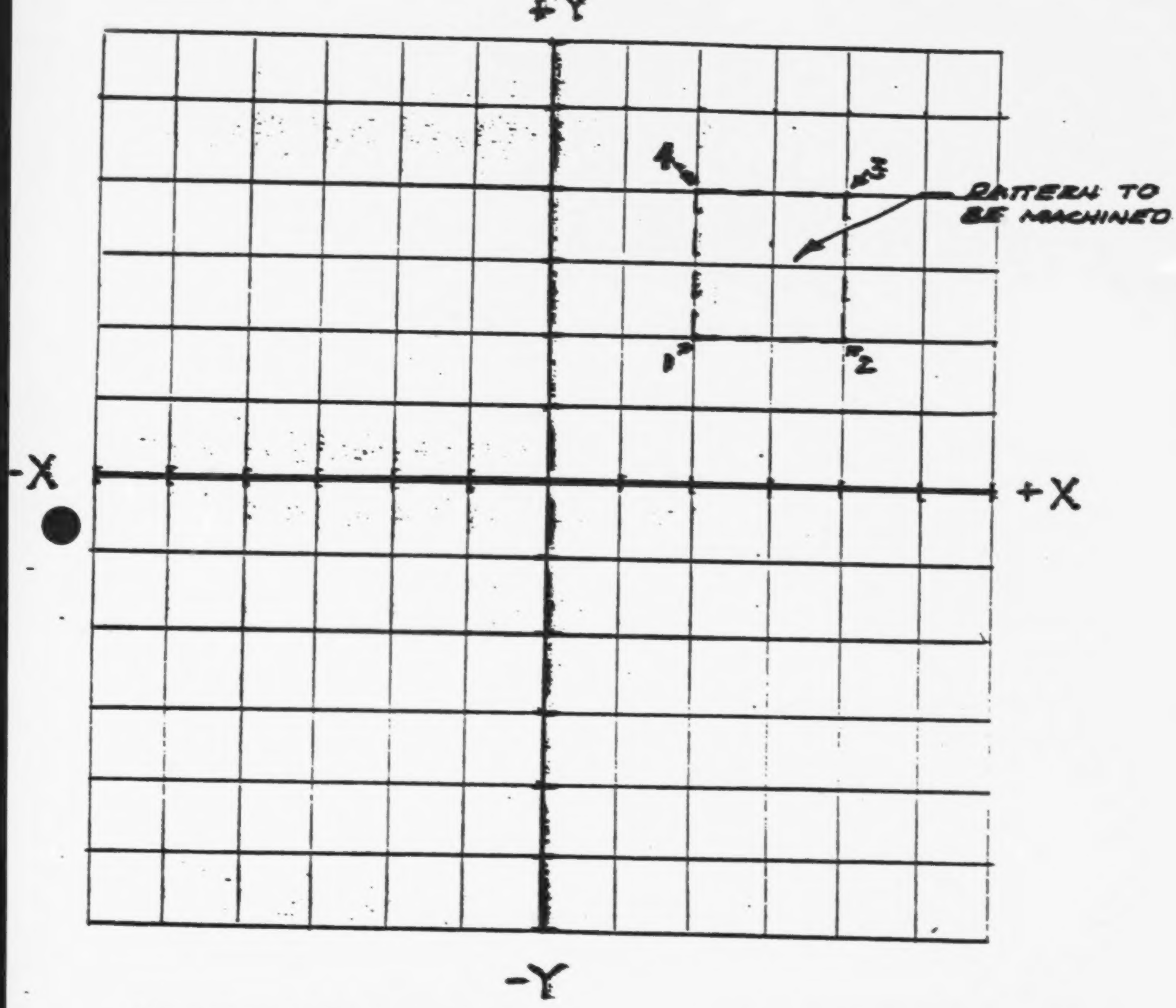
```
G54 X1.000 Y1.0 Z6.0
```

This code tells the machine exactly where the position is for workpiece Z.

```
N225 G83 X1 Y2 Z1.5 Q.2 R.1.
```

This code is a peckdrill cycle. This would drill a hole at position X1, Y2. The hole would be 1.5 deep (Z). The machine would drill .200 and then retract and then drill another .200 until the correct depth was reached, (Q). The R.1 tells the machine to move .100 above the piece between holes.

COORDINATES


+Y
4
3
PATTERN TO BE MACHINED
1
2
-X
+X
-Y

ACTUAL COORDINATES

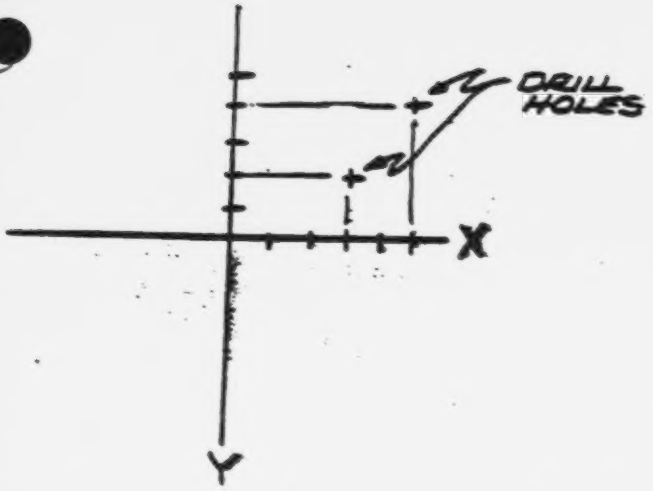
POINT	X	Y
1	2	2
2	4	2
3	4	4
4	2	4
1	2	2

ALLOWANCE (1"D. CUTTER)

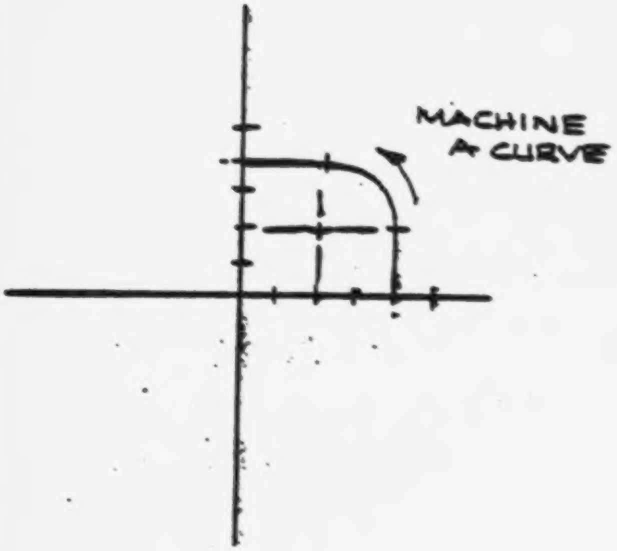
POINT	X	Y
1	1.5	1.5
2	4.5	1.5
3	4.5	4.5
4	1.5	4.5
5	1.5	1.5

SAMPLE PROGRAM

```
M06T1
G42-5
G54X1.5Y1.5
M03S400M08
G01X4.5Y1.5F5
G01X4.5Y4.5F5
G01X1.5Y4.5F5
G01X1.5Y1.5F5
G54M09
```


DRILL HOLES
X
Y

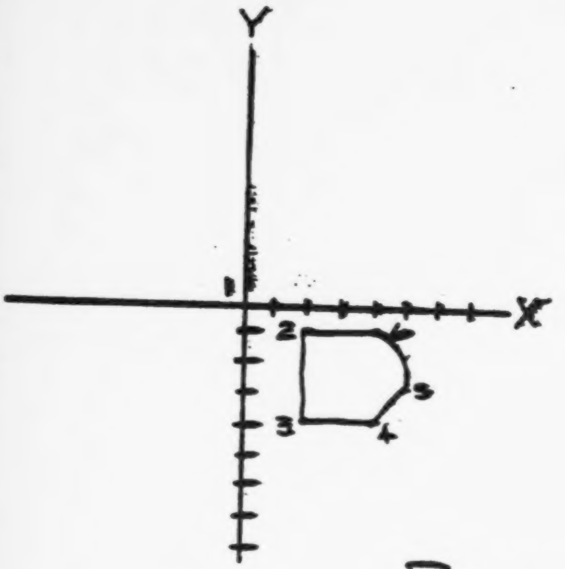
```
G83X3Y2Z1.25QR.1
G83X5Y4Z1.25QR.1
```


MACHINE A CURVE

```
G03X2Y3I2J2R2
```

2nd X-Axis

2nd Y-Axis



POINT	X	Y
1	0	0
2	2	-1
3	2	-4
4	4	-4
5	5	-3
6	4	-1
7	2	-1
8	0	0

PROGRAM TO ENGRAVE PATTERN

```
M06T1
G42.5
M03S400
M08
G00 X2Y-1
G01 X2Y4 Z-1F5
G01 X4Y-4 Z-1 F5
G01 X5Y-3Z-1F5
G03X4Y-1I4J-3 Z-1F5R2
G01X2Y-1 Z-1F5
G00X0Y0Z0M09
M02
```

Definition of Terms

CARTISIAN COORDINATES: Reference position of points of an object with respect to its horizontal, vertical, and depth axes.

CIRCULAR INTERPULATION: Using center of an arc and radius or the arc as a reference point.

CNC: Computer Numerical Control.

FEED: The rate (feet/second) at which a cutting tool transverses the material being machined.

G-CODE: Preparatory information and directions to the machine.

HOME POSITION: Starting position of the cutter of an NC machine. (000)

LINEAR INTERPULATION: A straight cut.

M-CODE: Miscellaneous functions the machine is to perform.

NC: Numerical Control.

PECK CYCLE: The procedure for increasing the depth of cut on a verticle milling machine.

RAPID TRANSVERSE: Moving as fast as possible from one position to another.

TOOL OFFSET: An allowance for the radius of a cutting tool.

WORK PIECE COORDINATES: The location of where the work piece is in respect to artisian coordinates.

X-AXIS: The horizontal axis in NC machines.

Y-AXIS: The vertical axis in NC machines.

Z-AXIS: The depth axis in NC machines.

Applied Math & Science Principles

Cartisian Coordinates

Relative numbering/calculations

Spatial relationships

Social/Environmental Impact

What effects has computer/numerical controlled machining had on the work force?

  a. Positive?
  b. Negative?

What effects has CNC machining had on the production of goods?

  a. Quantity?
  b. Quality?

Creative Problem Solving Activities

1. Write an NC program and machine the part on an NC machine.
2. If you do not have an NC milling machine, try the following:

   Design a school industrial technology logo.

   Have students operate the milling machine controls to simulate your program. Different student for each of the axes.

Related Careers

CNC Machine Operator/Programmer

Machine Tool Operator

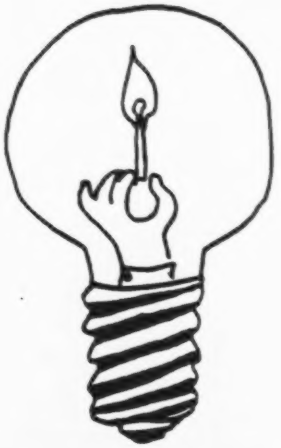
Computer Programmer

References

Activity Title	RESEARCHING AN EARLY INVENTION
Contributor	ED BALL
Time Required	2 WKS
Activity Description	In this activity, students will research and develop an early invention. They will build a scale model of an invention as close to the original invention as possible.

Terms

AGRICULTURAL REVOLUTION
INDUSTRIAL REVOLUTION
INVENTION
INVENTOR
PATENT



Objectives

To gain understanding of problem solving techniques through the building of an early invention model.

To develop research and development skills.

To become aware of the difficulties early inventors faced.

To develop oral skills involving technical information.

To construct a prototype model.

To become more aware of how important early inventions were to society yesterday, today and tomorrow.

Special Supplies & Equipment

Supplier

1. All materials are found and brought in by the student.
2. Teacher supplies only glue, scissors, tape, etc.

Transparency Masters
&
Student Handouts

RESEARCHING AN EARLY INVENTION

MATERIALS:

1. Glue, tape.
2. Scissors, blades.
3. Staples and pins.
4. Pipe cleaners.
5. Paint.

Definition of Terms

AGRICULTURAL REVOLUTION: When cultivation became the science and art of farming; work of cultivating the soil, producing crops and raising livestock for social and/or economical gains.

INDUSTRIAL REVOLUTION: The change in social and economic organization resulting from the replacement of hand tools by machine and power tools, and the development of large-scale industrial production, (about 1760).

INVENTION: To devise something new or an improvement to something already in existence.

INVENTOR: A person who invents; especially, one who makes or introduces a new contrivance, device, etc.

PATENT: An official document granting a right or privilege, or securing the exclusive right to invention; the invention itself.

Applied Math & Science Principles

Social / Environmental Impact

Although not all inventions have the same impact on society some are so significant that they have created the need for many more inventions to assist with the first. Many of our present day social and environmental problems have been caused by inventions.

Discussion of those which impact everyone in this country should be discussed and positives and negatives compared. Examples: automobiles, television, robots, and computers.

Creative Problem Solving Activities

1. Give an oral presentation on your invention covering:
   a. inventor.
   b. year.
   c. country.
   d. reason for inventing it.
   e. where it's evolved to today.
   f. a point of interest (neat fact relating).

2. Build a showcase for these using a 3x5 card describing all of the information in #1.

3. Discuss which inventions were needs and which were wants!

4. -Identify an invention that has made your life better.
   -List several negative and positive impacts this invention has made.
   -How could you counter one of the negative impacts?
   -How could you take advantage of one of the positive impacts?

5. -Choose a major tecnhology invention in your professional field.
   -List several negative and positive impacts this invention has made.
   -How could you counter one of the negative impacts?
   -How could you take advantage of one of the positive impacts?

Related Careers

- Production Worker
- Inventor
- Business Owner
- Scientist
- Mechanical Engineer
- Materials Engineer
- Manufactoring Specials
- Researcher
- Developer
- Prototype Specialist

References

Activities for Teaching Technology

Activity Title ELECTRICAL AND MECHANICAL THEORY

Contributor CHARLES GOSDZINSKI

Time Required MIN. 2 HR

Activity Description "Capsela" is a unique concept in construction sets which uses both electrical and mechanical theory. Through a series of easy snap-together interlocking parts and capsules, each with its own special function, you can assemble a variety of motorized models.

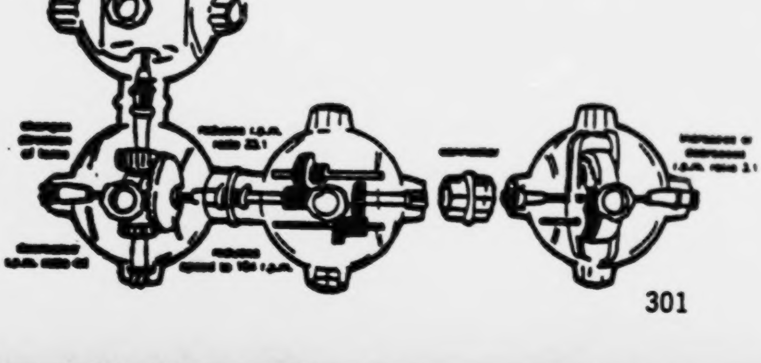
Capsela computerized allows for the design of state-of-the-art computer and remote control capabilities. Kids can design and program an endless variety of robotic creations.

This kit can be used with the multiple module concept. Several modules are presented to students at once. The modules must be completed within a certain time period (e.g. 1 week). A worksheet must be filled out or an evaluation given by the instructor for each module once the student completes it. Students may work independently or with others depending on class size or time frame.

Terms

CAPSULE
CLUTH
CROWN WHEEL
MECHANISM
RATIO
ROTARY
SPEED REDUCTION
TRANSMISSION
WORK GEAR

See Through Modules of Power!



Objectives

As a result of their learning experiences the students:

Understand basic electrical theory.

Understand basic mechanical theory.

Develop the ability to design vehicles when given the proper materials.

Develop basic psycho-motor skills.

Special Supplies & Equipment	Supplier
Capsela 1000	MAN 2
Capsela Computerized System 2000	MAN 3
Capsela Computerized System 5000	

Transparency Masters
&
Student Handouts

308

Definition of Terms

CLUTCH CAPSULE: This capsule is designed to engage or disengage the motor drive, either of the two gears can be disengaged by means of the double clutching mechanism.

CROWN WHEEL CAPSULE: This capsule allows you to change the direction of the motive force through a right-angle (90).

INTERNAL GEAR CAPSULE: This capsule changes the shaft speed without changing the direction of the drive.

SPEED REDUCTION CAPSULE: The capsule reduces the shaft speed but increases the torque or turning power. To function correctly the motor must be coupled to the input shaft, if, by accident, it is coupled to the output shaft the motor will not run. To discover which is the input shaft, turn both shafts in turn with your fingers. The input shaft is the one which turns easily.

TRANSMISSION CAPSULE: This capsule can be engaged between any functioning capsules to extend the gear action without changing the connecting gear motive force.

WORM GEAR CAPSULE: This capsule combines the function of the speed reduction and crown wheel capsule into a single unit. In so doing, you can both reduce shaft speed and change the direction of the motive force through a right angle.

Applied Math & Science Principles

Gear reduction principles

Basic electrical principle

Basic principles of mechanics

Social/Environmental Impact

As a result of our fast-paced technology it has been predicted that our students will change jobs several times in their lives. If this is true, then specific job skills have a doubtful place in the future of education. Several schools of thought feel that developing problem solving skills, creativity, and critical thinking skills will teach our students to "Roll with the punches."

Creative Problem Solving Activities

The possibilities are endless:

Though capsela shows you how to build various models you can create your own design and make it run.

Challenge students to create machines with given design parameters.

"Capsela Computerized" has a keyboard capable of storing up to 94 computerized commands. With the added feature of remote control, the transmitter allows either direct control of the robot or the activation of a pre-programmed routine.

Have an intra-class competition to determine whose functional creations are the most original.

Related Careers

Electricity/Electronics Technician and Engineer

Mechanical Engineer and Technician

Assembly Line Worker

Robotic Technician

Crane, Derrick, and Hoist Operator

Auto Mechanic

Industrial Engineer and Technician

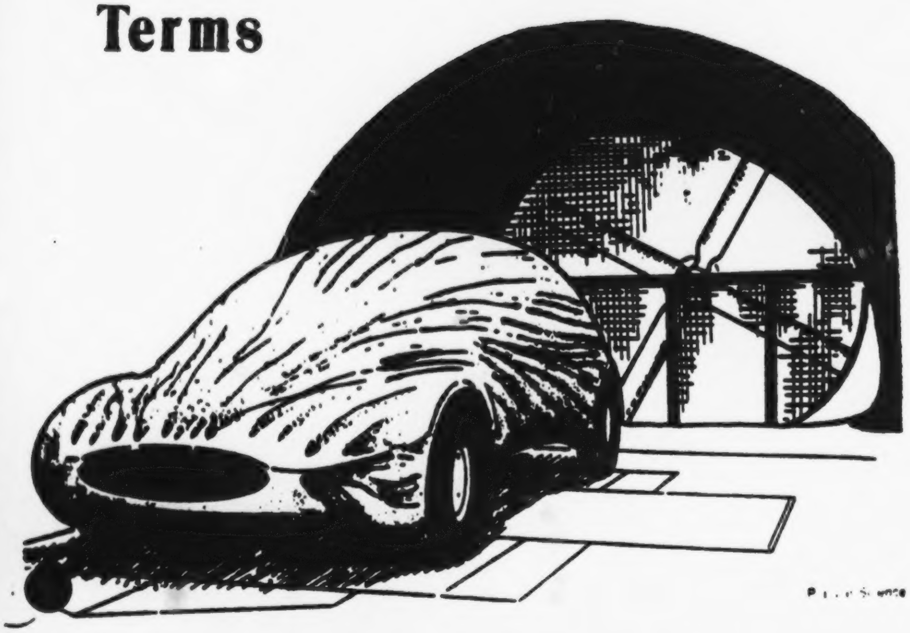
Industrial Designer

References

Activities for Teaching Technology

Activity Title	DESIGNING, ENGINEERING, R & D AND THE ROCKET CAR
Contributor	JAMES W. PARTRIDGE
Time Required	2 - 3 WEEKS
Activity Description	The student is to design, engineer, fabricate, perform select research and develop activities on the prototype of a rocket car.

Terms



Popular Science

AERODYNAMICS
CONSTANTS
DEVELOPMENT
DRAG
FORM DRAG
INERTIA
LAMINAR AIR
LIMITATIONS
RESEARCH
SKIN FRICTION
STREAMLINE
TRANSITION POINT
VARIABLES
VORTICES

Aerodynamics

Objectives

The student should be able to:

list and apply the techniques used by the industrial designer.

identify and apply the techniques used in Research and Development.

identify and apply the basic principles of aerodynamics to the design of a rocket car.

list the uses of the types of tests performed on the prototype of a product.

use selected mathematical formulas to gather engineering data for the rocket car.

Special Supplies & Equipment

1. Body blank for Rocket Car 1 5/8" wide x 2 3/4" high x 12" long
2. 1 5/8 x (1/8 axle hole rear wheels (2)
3. 1 1/2 x (1/8 axle hole front wheels (2)
4. 3/4 x 2 CO_2 cartridges
5. 4 x 8 sheet of masonite (ramp)
6. Starting and finish gate
7. Firing pins for starting gate
8. Fish line (10 lbs. test)
9. 2 stop watches
10. Sponges (thick)

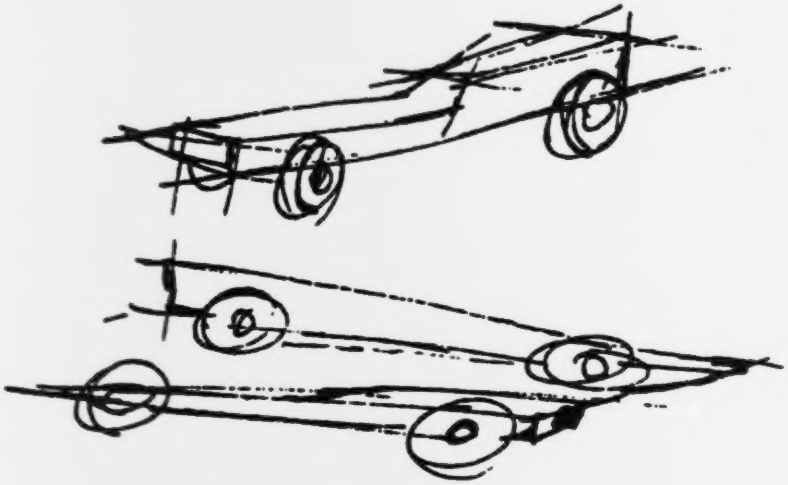
Supplier

Transparency Masters
&
Student Handouts

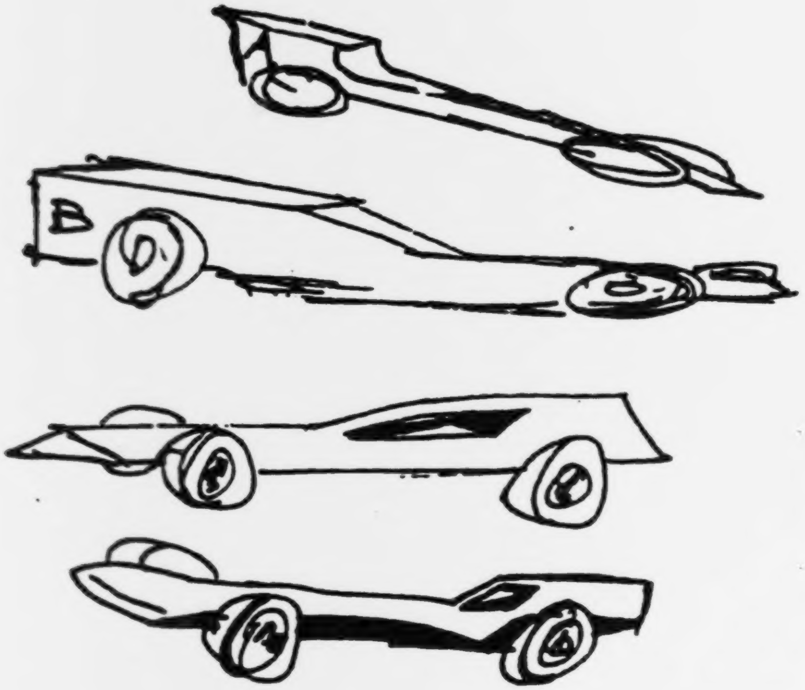
DESIGN ENGINEERING FACTORS

Factors	Limitations	Constants	Variables
Body Limitations			
Length	12" minimum and maximum	12"	none*
Width	1⅝" maximum	1⅝" minimum width at axles*	width can vary between axles*
Height	2¾" maximum	must enclose axles and engine*	height can vary between axles*
Shape	• ⅜" min. diameter one full piece	one full piece	any number of shapes
Axle housing	axles must be enclosed	1⅝" minimum width at axles	none*
Color	none*	may be constant	may be variable
Material	softwood	softwood	none
Power Plant Limitations			
Size and material	metal cartridge	¾" dia. x 2½"	none*
Location	totally enclosed	center line ⅞" above axle center line at all points	none*
Housing size	⅛" min. thickness around cartridge	¾" dia. x 2"	none*
Axle, Bearing, Wheel Limitations			
Axle size and material	⅛" dia. metal rod	⅛" dia. x 2½"	none*
Bearing size and material	⅛" I.D. minimum*	⅛" I.D. waxed paper tube	none*
Wheel size and material	1⅝" dia. plastic*	1⅝" dia. plastic	none*
Axle location	center line ⅜" from bottom	ground clearance	wheelbase
Steering System Limitations			
Screw eye alignment	on center line*	on center line	none*
Distance between screw eyes	minimum 6" apart	screw eyes*	none*

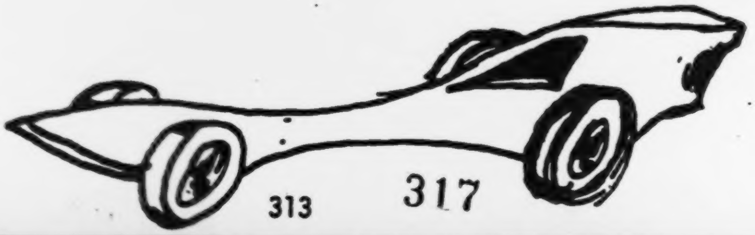
THE DESIGNERS SKETCH PROCEDURE



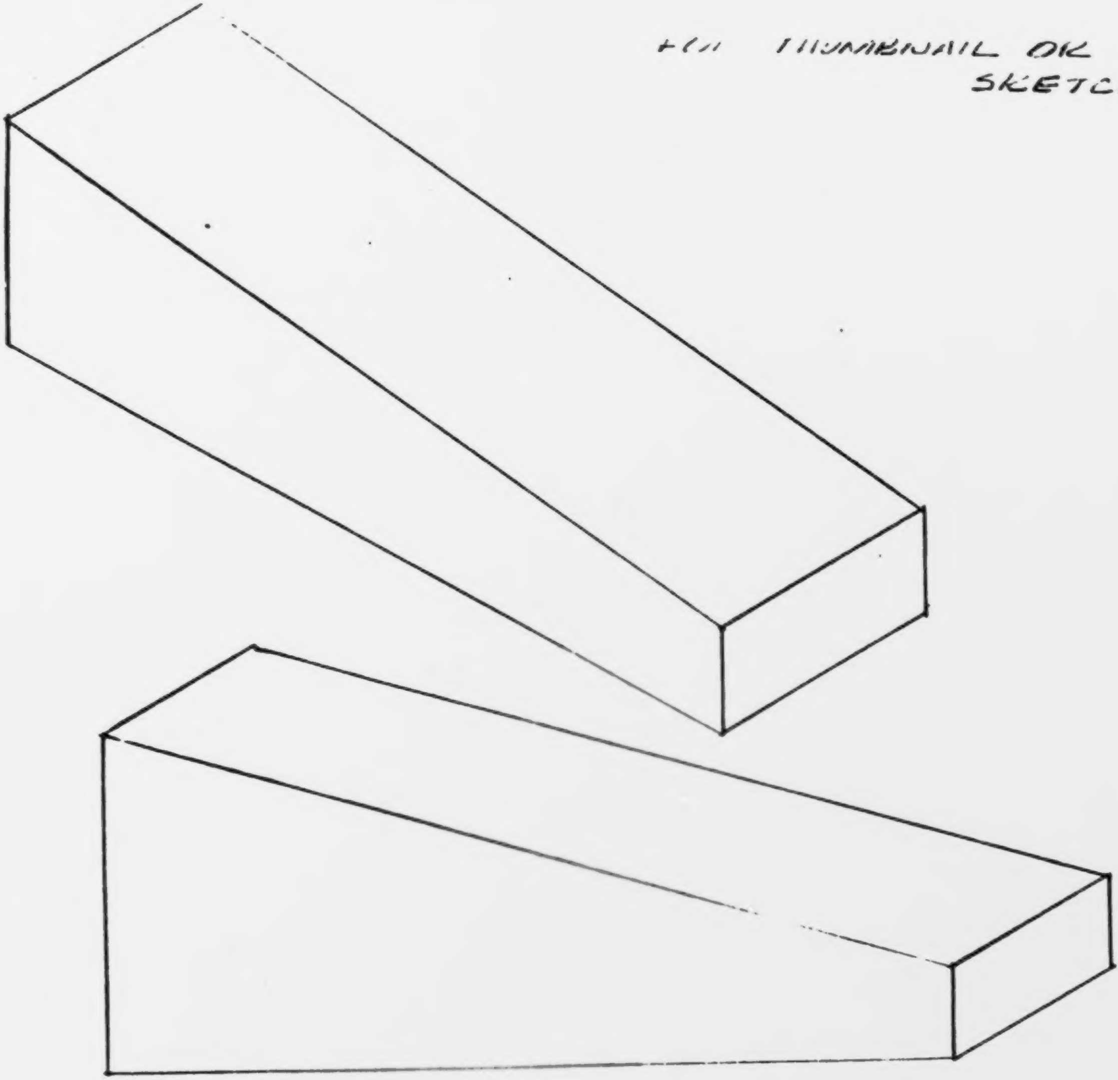
Thumbnail Sketches



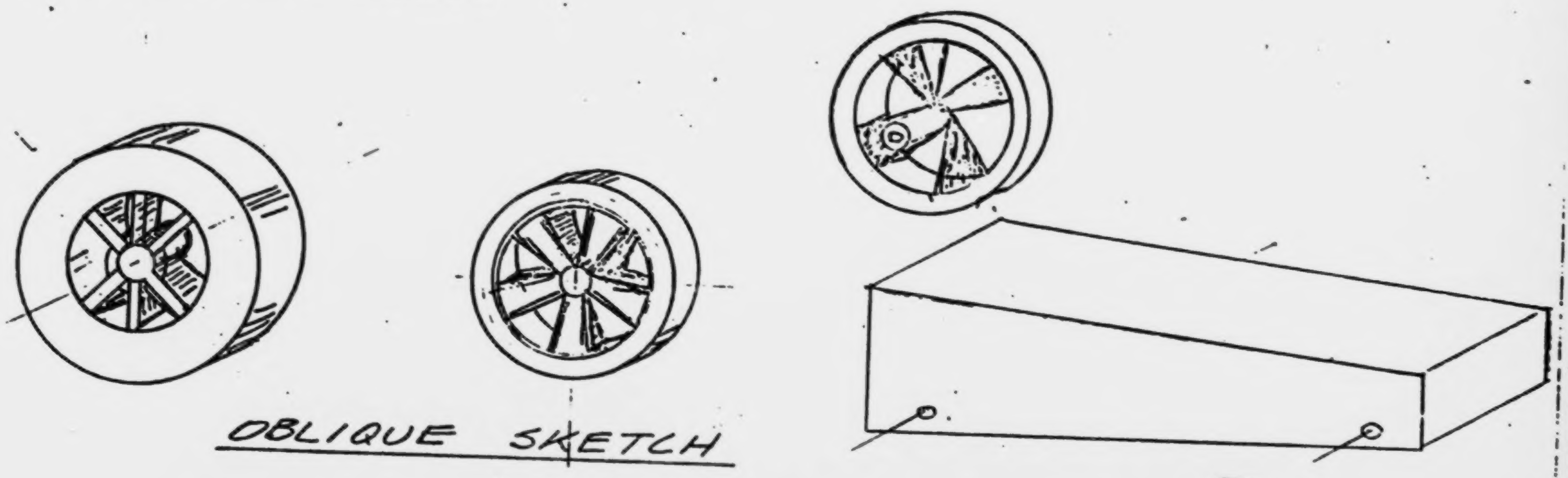
Rough Sketches



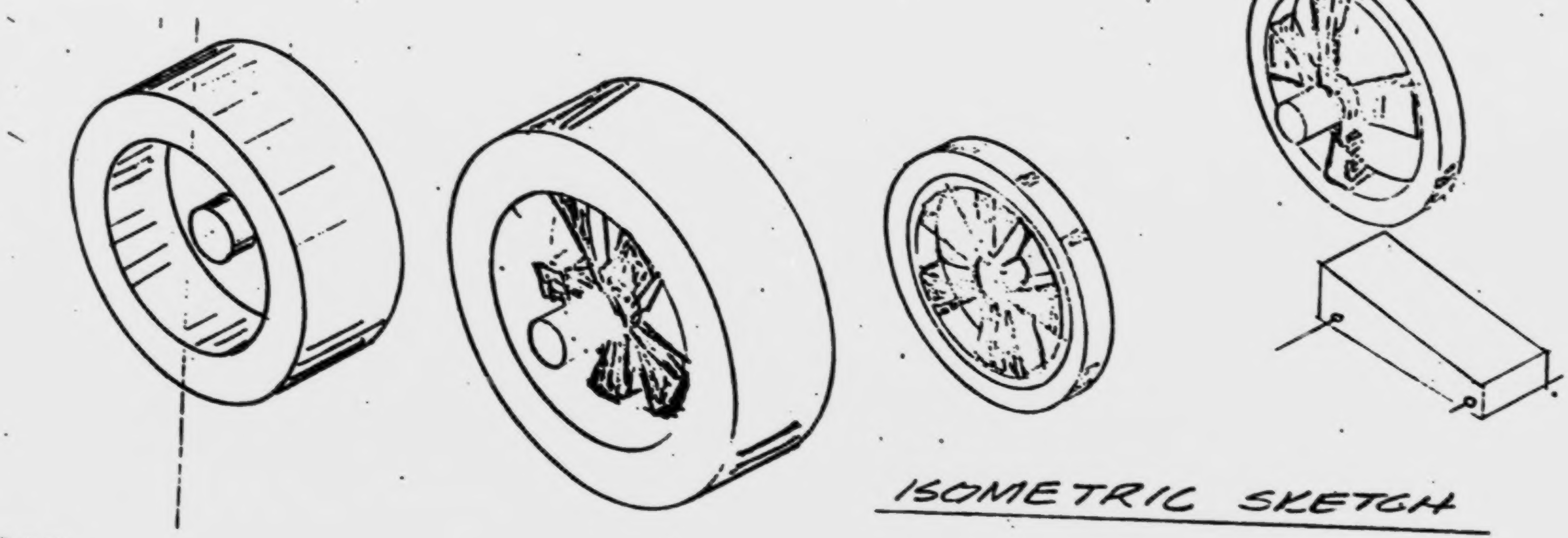
FOR THUMBNAIL OR ROUGH
SKETCHS



REFINED SKETCH WHEEL TEMPLATES



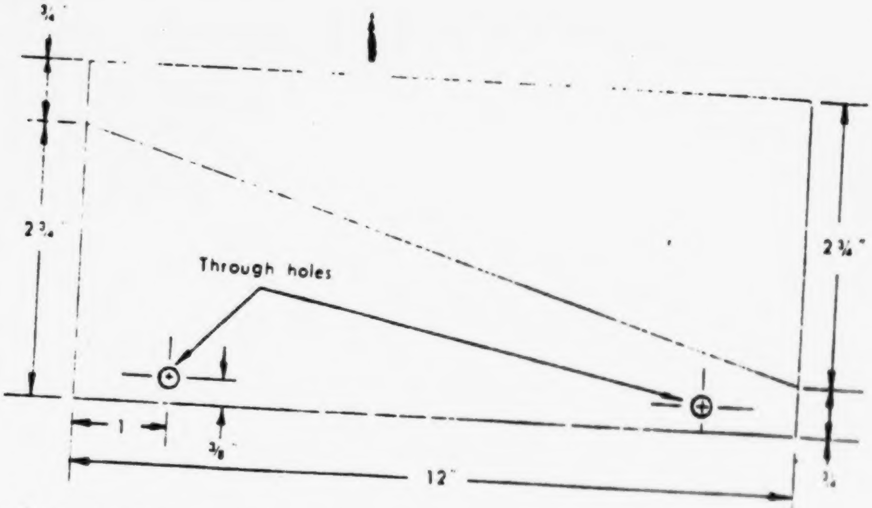
OBLIQUE SKETCH



ISOMETRIC SKETCH

319

320

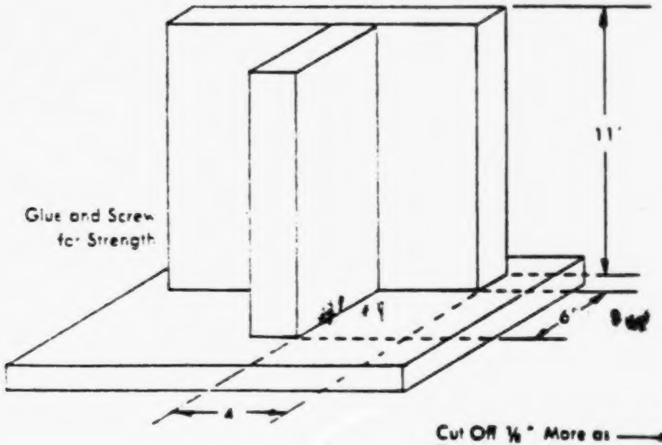

3/4"
2 3/4"
Through holes
2 3/4"
1
3/8"
12"
3/4

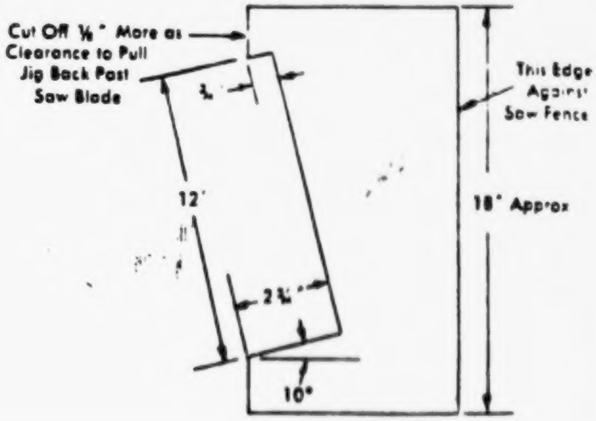
Pattern for Cutting Test Vehicle Bodies:
Cut two 12" from a 2" x 4" x 12" piece of lumber

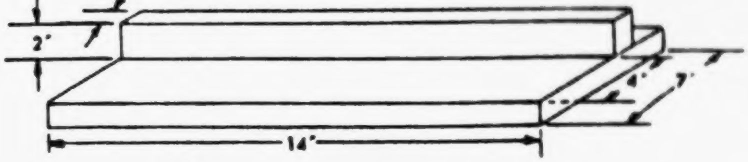
1 For Test Vehicle A with no bearings drill 9/64" holes

2 For Test Vehicle B with soda straw bearings, drill 3/16" holes or drill to fit

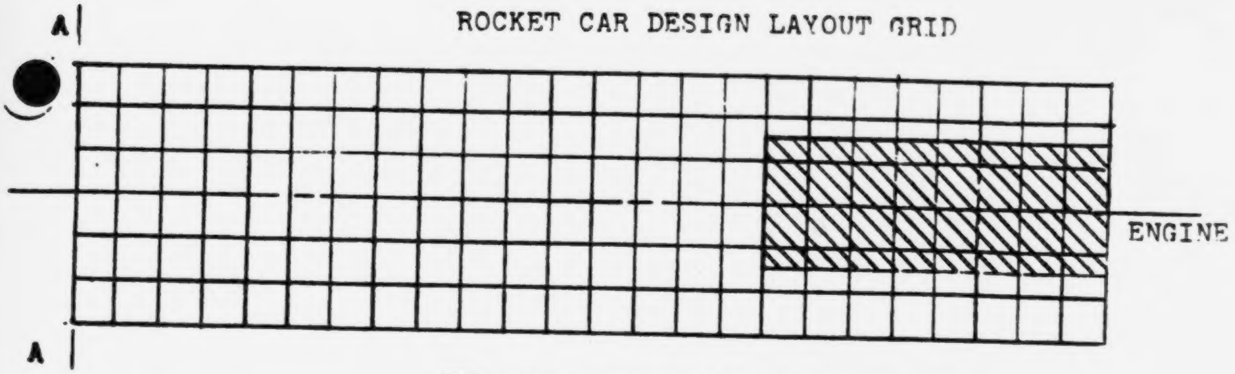
3 For Test Vehicle C with nylon bearings, drill 3/16" holes or drill to fit


11"
Glue and Screw for Strength
6"
4

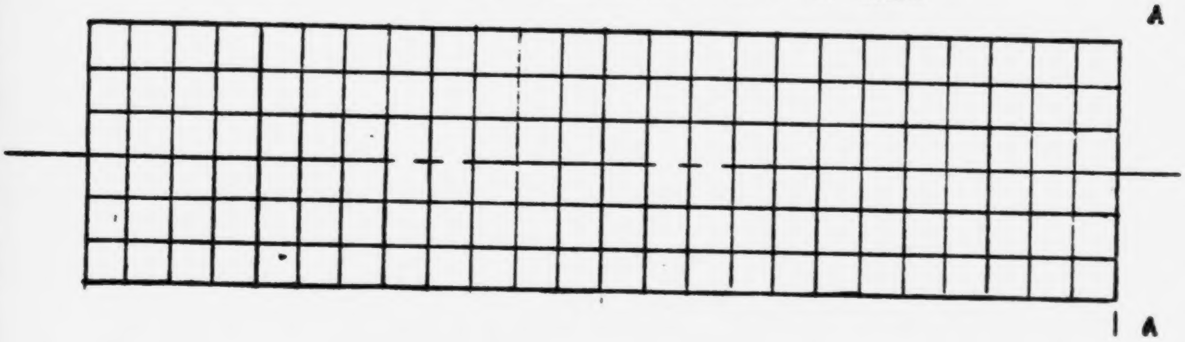

Cut Off 1/8" More as Clearance to Pull Jig Back Past Saw Blade
3/4"
This Edge Against Saw Fence
12"
18" Approx
2 3/4"
10°



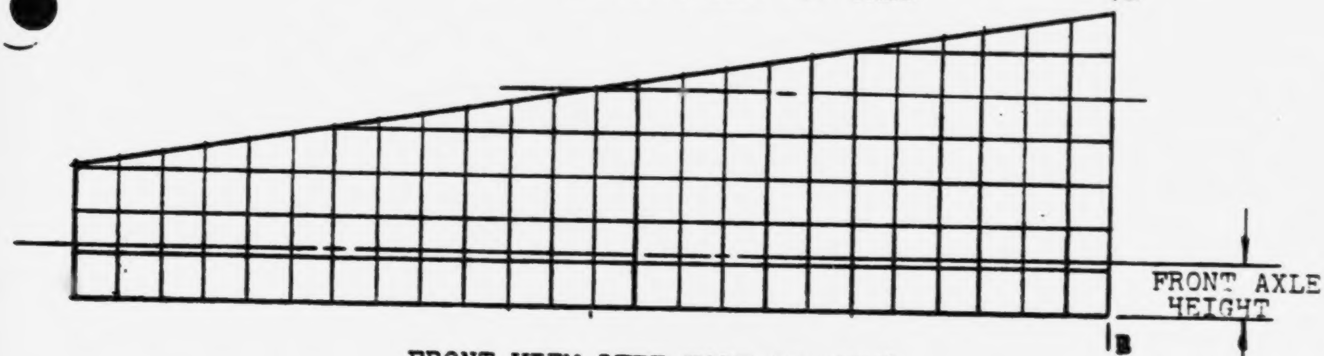
ROCKET CAR DESIGN LAYOUT GRID



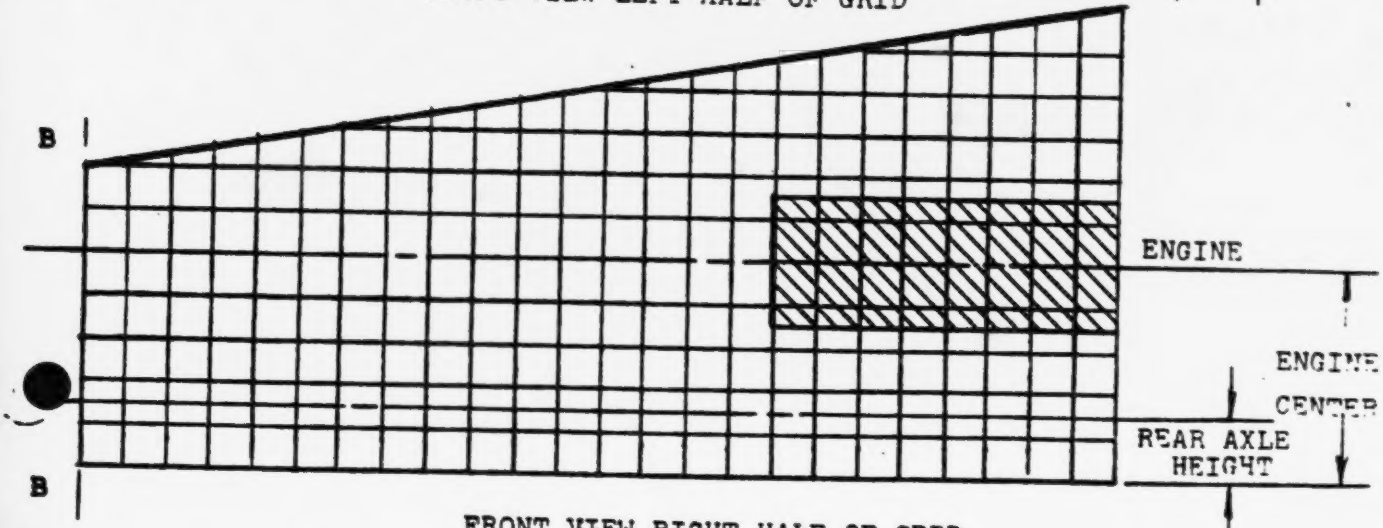
TOP VIEW RIGHT HALF OF GRID



TOP VIEW LEFT HALF OF GRID

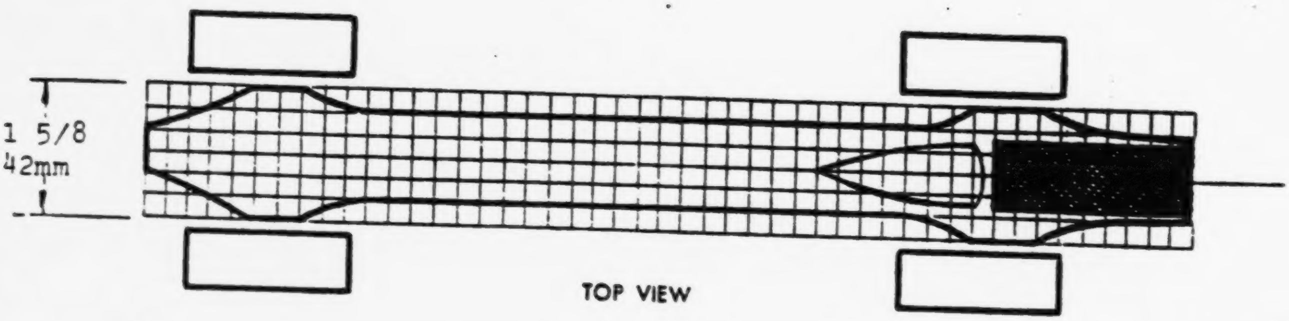

B
FRONT AXLE HEIGHT
B

FRONT VIEW LEFT HALF OF GRID

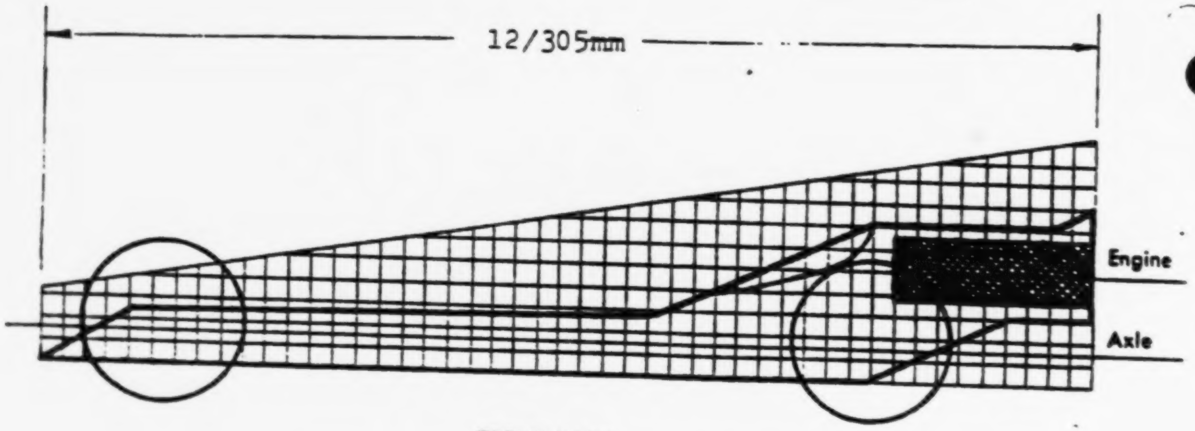

B
ENGINE
ENGINE CENTER
REAR AXLE HEIGHT
B

FRONT VIEW RIGHT HALF OF GRID

DESIGN LAYOUT GRID

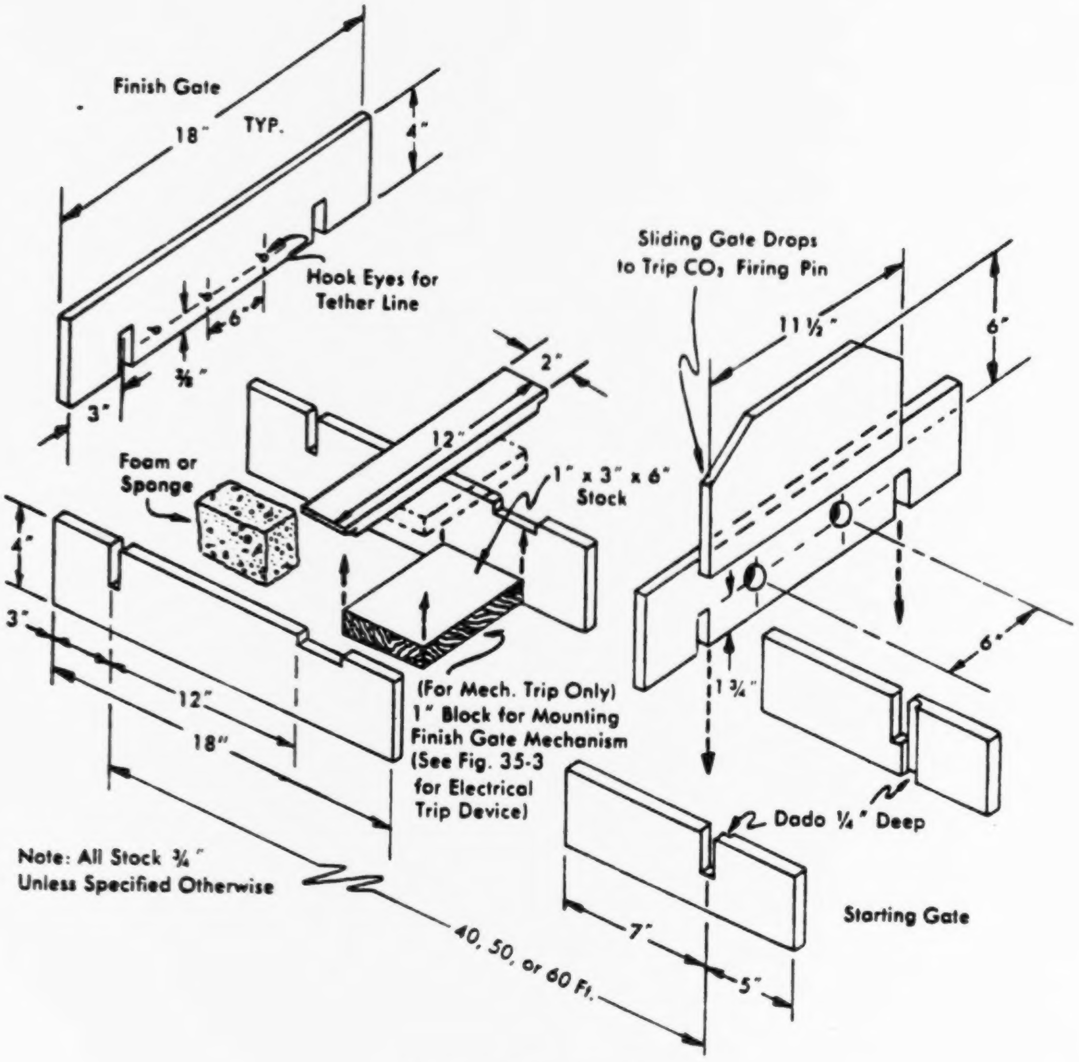


TOP VIEW

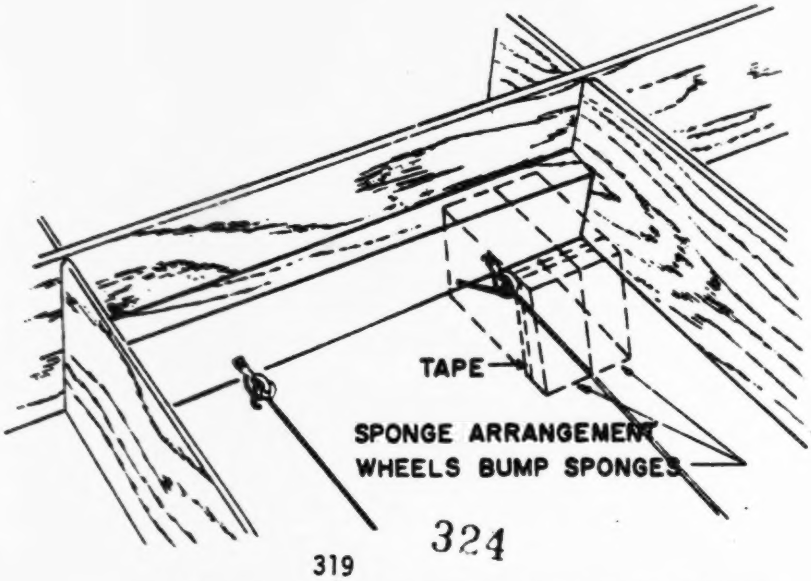

12/305mm
Engine
Axle

FRONT VIEW

SPECIFICATIONS: 305/12" LONG
42 mm/1 5/8 AT AXLES


Finish Gate
18" TYP.
4"
Hook Eyes for Tether Line
6"
3/8"
3"
2"
12"
1" x 3" x 6" Stock
Foam or Sponge
4"
3"
12"
18"
(For Mech. Trip Only) 1" Block for Mounting Finish Gate Mechanism (See Fig. 35-3 for Electrical Trip Device)
Note: All Stock 3/4" Unless Specified Otherwise
40, 50, or 60 Ft.
Sliding Gate Drops to Trip CO2 Firing Pin
11 1/2"
6"
6"
1 3/4"
Dado 1/4" Deep
7"
5"
Starting Gate

Start-Finish Gate Assembly


TAPE
SPONGE ARRANGEMENT
WHEELS BUMP SPONGES

Finish Gate Tether-Line Detail and Sponge-Stop Arrangement

ACTIVITY I

DESIGN ENGINEERING FACTORS WORK SHEET

Factors	Limitations	Constants	Variables
Body Limitations			
Length	12" minimum and maximum	12"	X
Width	1⅝" maximum	X	X
Height	2¾" maximum	X	X
Shape	⅜" min. diameter one full piece	One full piece	X
Axle housing	Axles must be enclosed	1⅝" minimum width at axles	X
Color	X	May be constant	May be variable
Material	Softwood	Softwood	X
Power Plant Limitations			
Size and material	Metal cartridge	¾" dia. x 2½"	X
Location	Totally enclosed	Centerline ⅞" above axle centerline at all points	X
Housing size	⅛" min. thickness around cartridge	¾" dia. x 2"	X
Axle, Bearing, Wheel Limitations			
Axle size and material	⅛" dia. metal rod	⅛" dia. x 2½"	X
Bearing size and material	X	⅛" I. D. waxed paper tube	X
Wheel size and material	X	1⅝" dia. plastic	X
Axle location	Centerline ⅜" from bottom	Ground clearance	Wheelbase
Steering System Limitations			
Screw eye alignment	X	On centerline	X
Distance between screw eyes	Minimum 6" apart	X	X

READING 1

ROCKET CAR DESIGNING AND ENGINEERING

The industrial designer must keep in mind many factors when designing a product. Five most general design considerations are: Ease of use, ease of maintenance, cost, producability of the product, and safety factors. Designers are classified in two general categories. The first is the corporate designer, this person works for a company full time. When a company wants fresh ideas or does not have a design department, the consultant designer is hired. A consultant designer usually works in a consultant firm rather than in a corporation. The designer must consider design factors such as limitations, constants and variables in the design process. Many solutions must be considered at the beginning of the design process. The reason for many design solutions is so that different ideas, materials, and ways of production may be compared. The industrial designer uses a four step design process to change the many possible design solutions from an idea to realistic object. The designer begins the design process with thumbnail sketches. Thumbnail sketches are quick sketches that capture the designers ideas on paper. Next, rough sketches are done to refine various thumbnail sketches. This can be done by using tracing paper to pick up whatever is worth copying or worth keeping as a good idea. In the third design step, the designer would choose from the rough sketches the one that seems to meet all the needs of the product or holds the most promise to solve the design problem. The refined sketch may be colored with colored pencils, watercolors, charcoal, air brushed or painted. This is done to make the refined sketch look more realistic and give fellow designers or management a chance to evaluate the design.

DESIGNING AND MODELS

The fourth step in the design process is model making. There are four types of models that can be made. The model may be made by the designer or a professional model maker. Models are scaled replicas of planned or existing objects. The four types of models a designer may choose from are:

A. Paste-up: The simplist type of model and least expensive. It is usually made of cardboard, construction paper, etc.

B. Appearance mock-up: A model that is made of inexpensive materials, usually not the same material used for the real product. Material like foamed styrene plastic, clay, plywood can be used to make this model.

C. Hard mock-up: This is a full scale three dimensional model, it may be made of the same materials as the original product, but all the parts of the hard mock-up may not work.

D. Prototype: The prototype is a full scale working three dimensional model. It is made of the same materials as the original product and all of its parts will work. This is the most expensive of all the models because all the parts work.

Models are made for many reasons. The following is a list of reasons a model may be made:

A. To show how a product will look.

B. To check for problems in the engineering of the product.

C. To solve production planning problems.

D. To solve problems in the design.

E. To photograph for advertisements.

F. To use in consumer surveys or to show to future customers.

G. To use for producability studies.

H. To use in market explanations or product presentations.

I. To use in human factors engineering studies.

J. To give the tool maker information for jigs and fixtures design.

The model maker is a specialist with many skills. The professional model maker needs to have the skills of the machinist, cabinet maker, pattern maker and painter.

In the fabrication of your rocket car prototype, you will learn how to use many of the same techniques and tools the professional model makers use. Once you have built your Rocket Car prototype, you will be using it to perform additional research and development activities to test your design, engineering and fabrication skills.

RESEARCH AND DEVELOPMENT

Research and development produce new knowledge and new or improved processes, materials or products. Research is the seeking of more new knowledge and development is the putting the new knowledge to work. There are two types of research that is done in industry. The first is pure or basic research. This type of research is not usually concerned with whether the new knowledge will or can be put to any use, now or later. The second type of research is research done mainly to produce knowledge which can be put to work.

Research is the processes of retrieving information, describing "what is" and experimenting. During the designing, engineering and testing of your rocket car, you will be applying some of these principles of research. The people who carry out research and development usually have formal training or education in science, technology, mathematics, and have a high degree of curiosity, leadership, readiness to work and ability to express themselves.

ACTIVITY #2

Student Activity: Rocket Car Research and Development

Objective: Using the necessary equipment and supplies, conduct an experiment to determine which of three given bearings have the least friction.

Materials and Supplies

6' steel tape
4 x 8 masonite for ramp
2 x 6 wood to support one end to make ramp
three identical wooden test vehicles as follows:
  Vehicle A, wood bearing
  Vehicle B, wax paper bearing
  Vehicle C, plastic soda straw bearing
six sets of wheels and axles
a piece of chalk
Bearing Friction Data Chart

Testing Procedure

1. Set up ramp.
2. Place test vehicle "A" at the top of the ramp and release it.
3. Mark with the chalk the point at which the vehicles forward motion stops.
4. Measure the distance from the end of the ramp to the chalk line and record the measurement on the Bearing Friction Data Chart.
5. Perform two more test runs for vehicle "A", measure and record each result.
6. Repeat the test for test vehicles "B" and "C" and record the results.
7. Average each trial for each vehicle and fill in the Bearing Friction Data Chart.
8. From your R&D experiment which bearing reduces the friction the best?

Bearing A	Wood
Bearing B	Waxed paper
Bearing C	Plastic soda straw

ACTIVITY 2

BEARING FRICTION DATA CHART

	Distances Run by Each Vehicle		
	A Wood Bearing	B Soda Straw Bearing (plastic or paper)	C Nylon Bearing
1st event			
2nd event			
3rd event			
Total Distance ÷ 3	$\frac{\quad}{3}$	$\frac{\quad}{3}$	$\frac{\quad}{3}$
Average			
Best Performance			

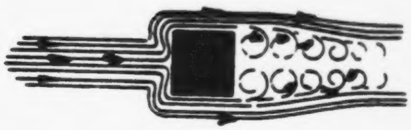
READING 2

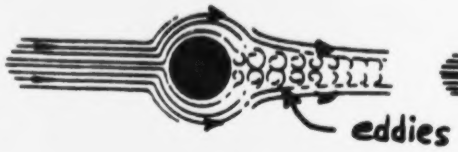
AERODYNAMICS

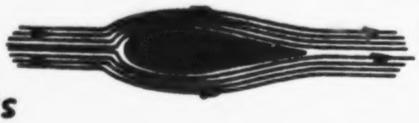
Aerodynamics is the study of air flow and the forces involved when an object moves through air or when air moves past an object. The objects we usually think of are airplanes, but the principles are the same for automobiles, sailing ships, and even structures, such as skyscrapers and bridges.

To engineer a Rocket Car that has good aerodynamic design, you must consider the properties of streamline, vortices, drag, form drag, skin friction, laminar air and transition point. Streamline is defined as the flow of air moving around a vehicle. Streamlined means that the air that separates at the front of your car flows over the body with the least resistance as it comes back together at the rear of your car.

Which shape below appears to be more streamlined?







The square and round shapes produce vortices at the rear of the shape because the air pressure is low at this point and causes the air to become turbulent. These "eddies" as they are also called produce uneven air flow and the effect produced slows the vehicle down. This effect is called drag. When the form of the object produces drag it is called "form drag".

"Skin friction" is a term given to the buildup of layers of air, known as "laminar air". As the layers of air build up they reach a "transition point" where the air becomes thickened and irregular and turbulent. One of the problems of aerodynamic design is to find out where the transition point begins on a car and change the design to delay its occurance as long as possible to cut down skin friction and therefore drag.

The problem of drag increases greatly when speed is added to our drag factor. When the speed is doubled the drag factor is cubed or even tripled. It has been estimated that 70% of a car's energy usage is used to overcome aerodynamic drag. Remember to sand the body of your rocket car smooth. Any roughness will cause skin friction to increase and cause excessive drag.

READING 2

NAME

Manufacturing
AERODYNAMIC READING STUDY QUESTIONS

1. Define aerodynamics.

2. What four forces affect airflow?

3. Define the "Law of Gravitation".

4. Define the "Center of Gravity".

5. Define the term "Lift".

6. Define "Angle of Attack".

7. Which type of airplanes use "Deflection" to produce their lift?

8. Describe vortices (eddies).

9. Define the term "Drag".

10. What causes "skin friction"?

INDUSTRIAL DESIGN QUIZ

1. What four design steps are usually followed by the industrial designer?

    A.
    B.
    C.
    D.

2. What are the preliminary sketches of a product design called?

3. Why are crude, freehand sketches valuable?

4. How does the designer get an idea of the general shape and size of the design solution?

5. What four types of models may a designer choose to better show the general shape and size of the design solution?

    A.
    B.
    C.
    D.

6. Name the model that is the least expensive for the designer to make.

7. Name the model that is the most expensive for the designer to make which will show his design solution.

8. Which model is a full scale working model of the product?

9. Could an appearance mock-up be made of foamed styrene plastic?

    A. Yes B. No

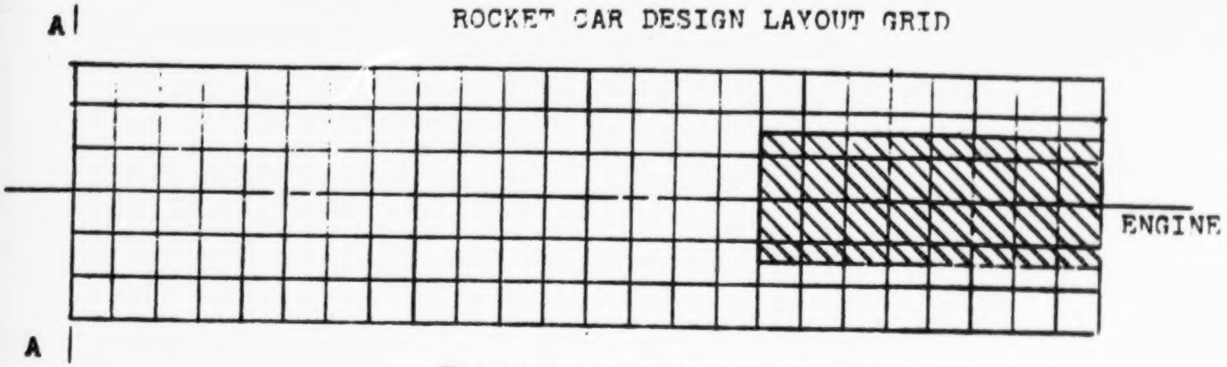
10. List four reasons why models or prototypes are made.

    A.
    B.
    C.
    D.

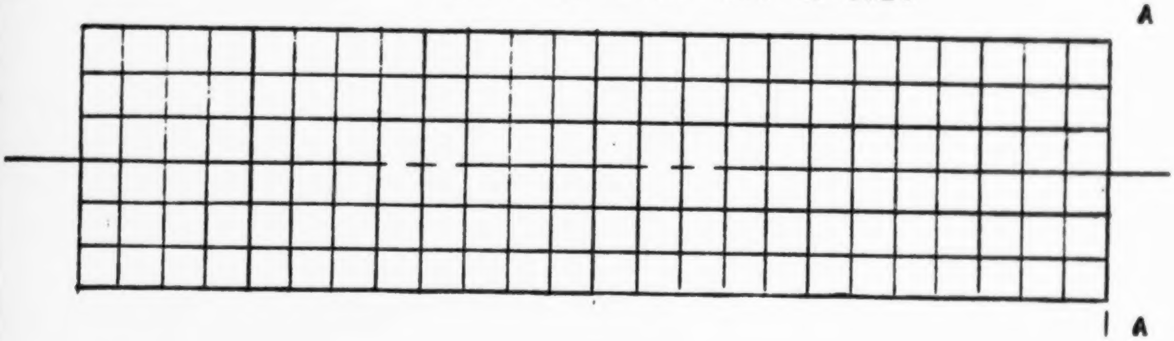
ANSWERS TO INDUSTRIAL DESIGN QUIZ

1. Thumbnail, rough, refined sketches and models
2. Thumbnail sketches
3. They quickly capture the designer's ideas on paper.
4. The designer makes a model to better explain his design solution.
5. A. paste-up B. Appearance C. Hard mock-up D. Prototype
6. Paste-up
7. Prototype
8. Prototype
9. A. Yes
10. The student may list any of the seven reasons given in his reading.

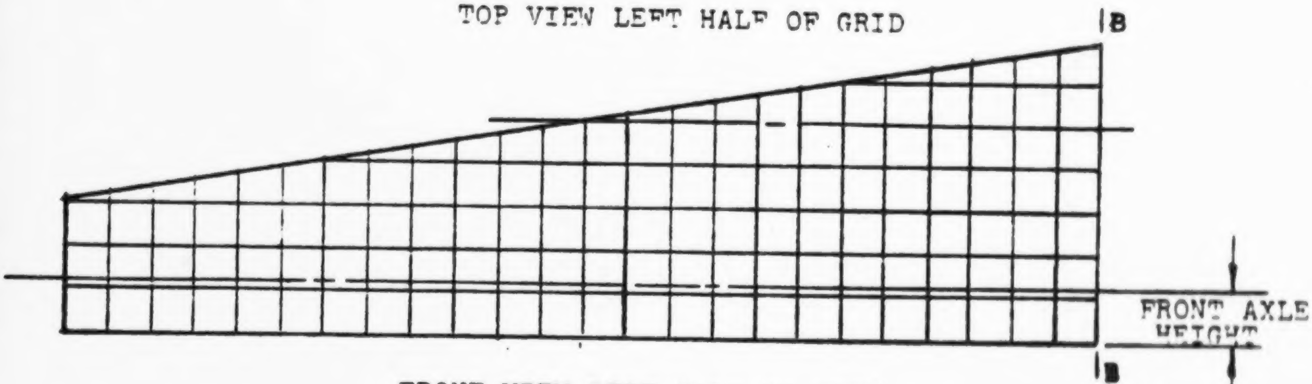
ROCKET CAR DESIGN LAYOUT GRID



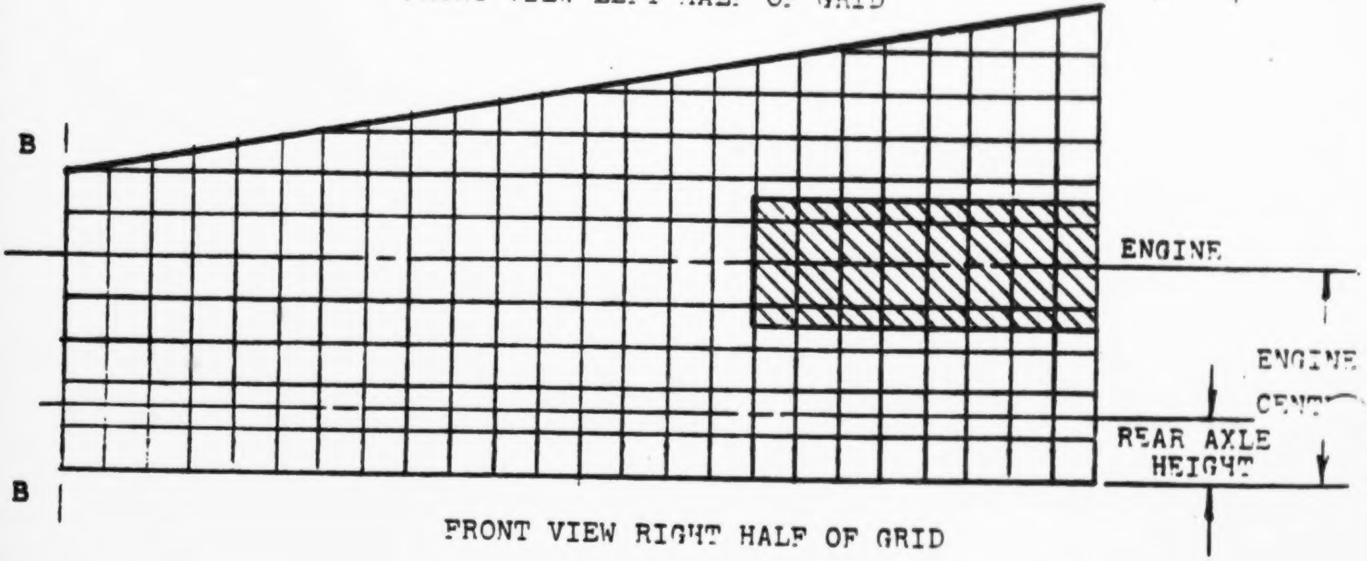
TOP VIEW RIGHT HALF OF GRID



TOP VIEW LEFT HALF OF GRID


B
FRONT AXLE HEIGHT
B

FRONT VIEW LEFT HALF OF GRID


B
ENGINE
ENGINE CENT
REAR AXLE HEIGHT
B

FRONT VIEW RIGHT HALF OF GRID

Student Activity: Rocket Car Design -Engineering- Fabrication

Objective: Using the necessary equipment and supplies design, engineer and build a prototype of a Rocket Car that has good aerodynamics.

Materials and Equipment

Three sheets of 8 1/2 x 11 tracing paper
Sketching pencils (2H, H, HB)
Assorted french curves
Preprinted design layout grid
Poster board for templates
Design Factor sheet
Wooden blank for rocket car
Scissors or matt knives
Two 1 5/8 diameter rear wheels
Two 1 1/2 diameter front wheels
Two axles 1/8 diameter x 2 1/4
Two screw eyes (for guidance system)
Rubber cement

Design and Engineering

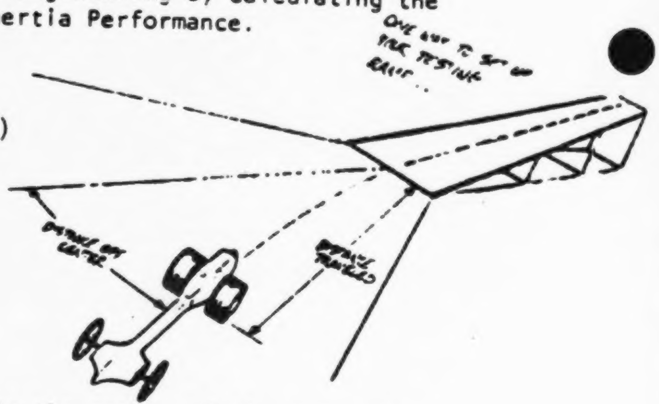
1. Fill in Design Factors sheet as directed by the instructor.
2. Using tracing paper, make eight thumbnail sketches.
3. Using tracing paper, make three rough sketches.
4. Refine one rough sketch.
5. Draw with french curves your refined sketch design solution on the design layout grid. (Locate axle holes on axle center lines found on the grid.)
6. Rubber cement completed grid layout to poster board to make a top and front view templates.
7. Use templates to trace your design solution on the wood blank.

Fabrication

1. Locate axle holes and drill.
2. Saw shape of car out of wooden blank.
3. File and sand until smooth.
4. Prime and paint your Rocket Car.

Student Activity: Rocket Car Prototype Engineering Test

Objective: Check wheel assembly for proper engineering by calculating the Accuracy Ratio and calculate Inertia Performance.



Materials and Supplies

6' steel tape (with Metric graduations)
4 x 8 sheet of masonite for Ramp
2 x 6 wood to support ramp
Chalk
Balance beam scale (grams)

Testing Procedure (Accuracy Ratio)

1. Set up Ramp.
2. Mark a center line on the Ramp.
3. Place vehicle at the top edge and in the center of the ramp and release it.
4. Measure the distance from the end of the ramp to the point the vehicle stopped its forward motion and record on your worksheet.
5. Measure the distance off center and record and note your findings on your Accuracy Ratio Worksheet.

Testing Procedure (Inertia Performance)

1. Measure the weight of your car using the grams scale. (The car must be weighed with the CO_2 cartridge.)
2. Measure the distance traveled down the testing ramp and note your findings on the Inertia Performance Testing Worksheet.

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WHEEL ALIGNMENT

1. Total distance traveled in millimeters was __________.
2. Total distance of center in millimeters was __________.
3. Accuracy equals DC ______ divided into DT ______.
4. Compute the ratio of your accuracy below.

Use the following formula for Inertia Performance:

$$\text{Inertia Performance} = \frac{\text{Distance Traveled}}{\text{Weight of Car}} \qquad IP = \frac{DT}{W}$$

1. Total distance traveled in millimeters was __________.
2. Total weight of car in grams with cartridge __________.
3. Calculate performance by dividing weight of the car into the distance traveled.

Answer the following questions about the Inertia Test.

1. How did your car score _______________.
2. Compare it to the ratings of your classmates _______________.
3. If they achieved a better score, was this due to a more streamlined design? _______________
4. Does weight play an important role in this test? _______________

Definition of Terms

AERODYNAMICS: The study of air flow and the forces involved when an object moves through air or when air moves past an object.

CONSTANTS: Design factors that stay the same when designing a product.

DEVELOPMENT: The work of designing and engineering new or improved processes or products by using research findings and other knowledge.

DRAG: Air movement caused by a vortex that is uneven or turbulent which causes friction against the objects surface.

FORM DRAG: Drag due to the shape of the form of the object.

INERTIA: The tendency of an object to remain in its original state of rest until some force acts upon it to change it or if in motion, the tendency for it to remain in motion until another force either halts it or changes its direction.

LAMINAR AIR: Air that is layered or laminated with no mixing with one layer sliding over another.

LIMITATION: Those design factors of material, size, shape, weight that will influence the designer and the way a product is designed.

RESEARCH: Seeking new knowledge by retrieving information of what has been done in the past, describing "what is", and experimenting using limitations, constants, and variables to find answers to problems.

SKIN FRICTION: The friction caused by layers of air sliding over other layers or air as the air passes off an irregular object.

STREAMLINE: The flow of air moving around a vehicle.

TRANSITION POINT: The point at which laminar air becomes thickened and irregular or turbulent.

VARIABLES: Factors that will change as the designer designs a product.

VORTICES: "Eddies" as they are also called in air that breaks away from a rounded or square shape and forms into swirles of air which results in turbulance which causes drag.

Applied Math & Science Principles

NEWTON'S THIRD LAW OF MOTION: "To every action, there is always an equal and opposite reaction."

BERNOULLI PRINCIPLE: The faster air moves, the lower its pressure.

Speed = distance — time

Thrust Equation for Rocket Engines:

$$F = \frac{WVe}{g} + (P_2 - P)\ A^2$$

WHERE: F = pounds of thrust
W = flow rate of gases through on engine (lbs/sec)
Ve = exit velocity of gases (ft/sec)
g = acceleration due to gravity 32.2 (ft/sec)
P_2 = exit pressure at nozzle (psi)
P = local atmospheric pressure (psi)
A^2 = nozzle exit area (inches^2)

Social / Environmental Impact

Designers and engineers need to concern themselves with the safety and social impact of the products they design and engineer to be used by people. It is their responsibility to be aware of the materials they use and the methods of processing of those materials they are not damaging the environment (land, air, and water). They need to examine the social impact of what they design. How is the product going to affect the people that do not use the product? How is the product going to affect the people that do use the product? It is the social responsibility of the designer and engineer to research the safety factors of the product both short term use and long term use. Then the consumer must be informed of the possible hazards or consequences of improper use to the product. A concern for the conservation of energy during the use of the product

Applied Math & Science Principles

Social / Environmental Impact (Continued)

and the disposal of the product at the end of its useful cycle must also be dealt with by the designer and engineer.

The study of Transportation Technology should include the study of aerodynamics so that future vehicles can be designed with a minimum of drag and friction. A vehicle that has good aerodynamics will have a low level of energy consumption which in the long run will on a larger scale benefit both the society and the environment.

Creative Problem Solving Activities

1. Design and engineer a wind tunnel to test the aerodynamics of each student's rocket car.
2. Design, write, and assemble an owner's manual that could be included in the packaging of the rocket car if it were to be sold to consumers.
3. Design a trademark that could be used by a company that would market and manufacture the rocket car.
4. The students would be required to design, engineer, and fabricate a drilling fixture that would hold the rocket car body blank for drilling of the axle holes or the engine hole.
5. The student could design two different types of drilling fixtures and perform time and motion study using video tape recorder and camera to evaluate the drilling fixtures for the best performance.
6. Students could design, layout and assemble a package for the rocket car that would have a company's name and trademark printed on as well as other consumer information.
7. Design a flowchart poster that would show the step by step procedure in the fabrication of the rocket car.
8. Draw a floor plan of the plant layout that would show the manufacture of the rocket car.
9. Design a market research questionnaire that could be used to gather information about the consumers' likes, dislikes, selling price or any other consumer information that the students deem important to know. Then have students evaluate the data and submit a written report on the information findings.

Related Careers

- Corporate Designer
- Consultant Designer
- Scientist
- Aerospace Engineer
- Product Designer
- Industrial Designer
- Automotive Engineer
- Model Maker
- Tool Maker
- Technicians
- Commercial Artist
- Machinist
- Cabinet Maker
- Pattern Maker
- Draftsman

References

"Aerodynamics in Junior Engineering": Pitso Inc., Box 1320, Pittsburg, KS 66762, ($2.00 each).

Donald G. Cux and Willis E. Ray, (1971) The World of Manufacturing, McKnight & McKnight Publishing Company, Bloomington, Illinois.

Rocket and Science Series, Vol. I: Propulsion (1962), (Amateur Rocket Association book).

Activities for Teaching Technology

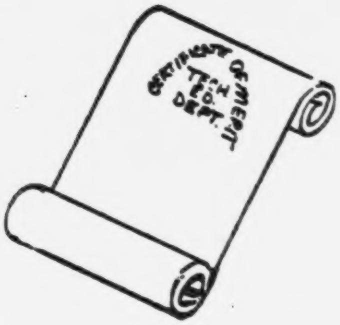
Activity Title PAPER MAKING

Contributor CHARLES GOSDZINSKI

Time Required 3 HRS

Activity Description The first hour of the activity is spent mixing the pulp, pressing and forming the paper. The paper must dry for two days. The second hour of the activity should be spent introducing students to paper making processes. Hand out and audio visual aids are encouraged. Part of the hour should be spent discussing the social and environmental impact of recycling. The third day students will utilize the paper by printing, decorating or writing on it.

Terms



Objectives

Demonstrate the technique of recycling common paper.

Special Supplies & Equipment | Supplier

1. Plastic bucket
2. Shallow pan
3. Pieces of window screen
4. Wax paper
5. 16 oz. tin cans
6. Newspaper
7. Manual or electric egg beater

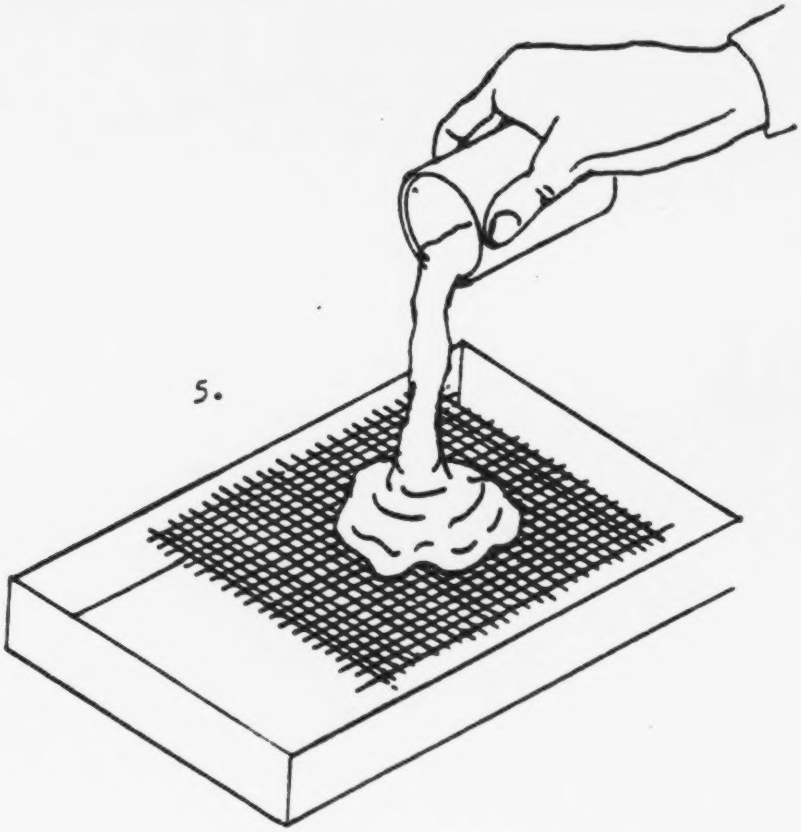
Transparency Masters
&
Student Handouts

ACTIVITY HANDOUT

PURPOSE

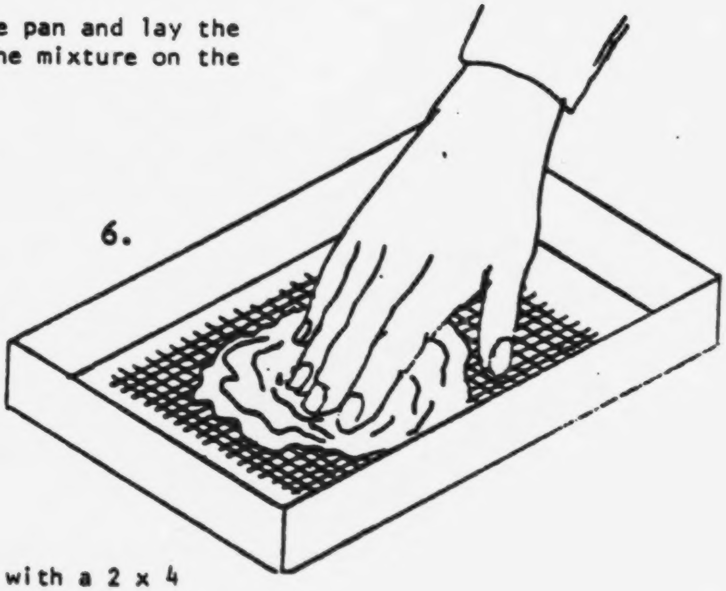
To demonstrate the technique of recycling

1. Cut into small pieces a sheet of newspaper 30 cm x 30 cm. Put the pieces of newspaper into the plastic bucket.
2. Pour about 1½ cups of water per student into the bucket. Let the newspaper soak in the water for 5 minutes.
3. Use the eggbeater to mulch the newspaper and water until the paper looks like cooked oatmeal.
4. Add 10 gm of flour per student, mixing it thoroughly with the churned newspaper.
5. Have someone hold the window screen over the pan. Then pour the mixture onto the screen to drain.



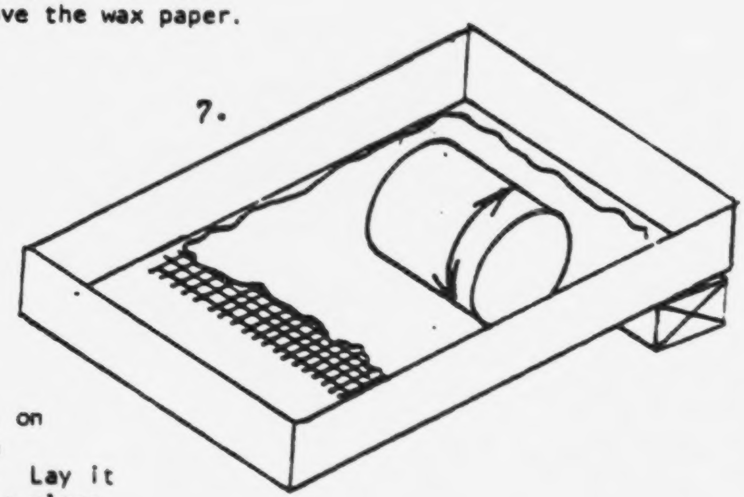
5.

6. Empty the water from the pan and lay the screen in it. Spread the mixture on the screen in a thin layer.



6.

7. Prop one end of the pan with a 2 x 4 piece of lumber. Lay wax paper over the mixture on the screen. Then roll the jar over the mixture to press out more water. Empty the water from the pan and carefully remove the wax paper.



7.

8. With the mixture still on it, carefully take the screen out of the pan. Lay it on a block of wood in a place where it will not be distrubed for about two days. When the mixture is completely dry, peel the recycled paper off the screen.

REPORT

1. Describe the appearance of your recycled paper.
   The paper will probably be thicker and not as white as the original paper. It may also be unevenly thick and have a rough texture.

2. Look for recycled-paper products in stores. What kinds of products are made of recycled paper?
   Some products made from recycled paper are tissue products, writing paper, picnic ware, boxes, newsprint, and containers.

The Chinese Invention Of Paper

When Marco Polo returned from his travels to the East, he brought back a record of China that showed a civilization, which in the thirteenth century, had come into full bloom and was much more advanced than that of contemporary Europe. Today scholars believe that certain processes that had gradually evolved in China, coupled with the civilization of Rome and Greece, had much to do with starting Europe forward on her course of literary progress. One of the most important of the inventions of China which spurred the forward progress of European printing was the development of the paper making process.

China's earliest known way of recording its picture alphabet was by means of "oracle bones" (2000 B.C.) found in ancient burial sites. These bones were used as a means of divination. Up until the end of the Chou dynasty (256 B.C.), through China's classical period, writing was done with bamboo pen, with ink of soot, or lampblack, upon slips of bamboo or wood. Wood was used largely for short messages, bamboo for longer writings and for books. The bamboo was cut into strips about 9 inches long and wide enough for a single column of characters. The wood was sometimes in the same form, or sometimes wider. The bamboo strips were perforated at one end and strung together, either with silk cords or leather strips to form a book. With the end of the Chou dynasty, a new change came into being in the Chinese language. The word for writing materials became "bamboo and silk" instead of "bamboo and wood". There is evidence that the silk "chih" used for writing during the early part of the Han dynasty consisted of actual silk fabric. Still, due to the fact that silk was too expensive and bamboo too heavy, a new median of recording characters upon was sought.

The year 105 A.D. is usually set as the invention of paper, because in that year the invention was officially reported to the emperor. In 1931, a Swedish archaelogist Folk Bergman discovered probably the oldest paper in the world while excavating a Han ruin. The manuscripts he found were recorded on wood and silk rags and were dated to the years 89-105 A.D. Examination of paper from Turkestan in China, dating from the third to the eighth centuries, shows that the materials used were the bark of the mulberry, hemp both in raw form and fabricated form (fish net), and various plant fibers, expecially Chinese grass, not in their raw form but taken from rags. The Han dynasty historian Fan Yeh (fifth century A.D.) gives the following account of the invention of paper.

> "Then Ts'ai Lun thought of using tree bark, hemp rags and fish nets. In the first year of Yuan-hsing period (105 A.D.) he made a report to the emperor on the process of papermaking and received praise for his ability."1

The use of paper, which was superior to bamboo and silk as a writing material, made rapid progress. Still, it was regarded as a cheap substitute. The earliest papers are a simple net of rag fibers with no sizing. The first attempt to improve the paper so that it would absorb ink more readily, involved giving the paper a coat of gypsum. Then followed the use of glue or gelatin made from lichen. Next came the impregnation with raw dry starch flour. Finally the starch flour was mixed with a thin starch paste, or else the paste was used alone. Better methods of softening the paper came into use that proved less destructive of the fibers and produced a stronger paper.

All these improvements were perfected by the Chinese before they passed it on to their Arab captors at Samarkand in the eighth century and which in turn was passed on by Moorish subjects to their Spanish conquerers in the twelvth and thirteenth centuries. Thus the invention spread throughout the world.

Applied Math & Science Principles

- Basic physical science principles are reinforced.

Social/Environmental Impact

Forest lands are saved - ecosystems are saved.

Manufacturing energy saved.

Materials are utilized to the full potential.

Jobs are lost and created.

Littering is discouraged.

Creative Problem Solving Activities

1. Determine ways to improve texture of paper.
2. Color paper using various coloring solutions.
3. Develop a press to emboss paper.
4. Develop a process to improve the consistence of recycled paper.

Related Careers

Compositer and Typesetter

Printing Press Operator

Retail Buyer

Refuse Collector

Chemical Engineer and Tehcnician

Chemist

Drafter

Industrial Engineer and Technician

Book Binder

Paper Manufacturing Machine Operator

References

1. Hou Han shu, chuan 108, biography of Ts'ai Lun.
2. Carter, Thomas. The Invention of Printing in China. New York, The Ronald Press Co., 1955.

Supplier List

COM 1 - Metrologic Instruments
143 Harding Avenue
P.O. Box 307
Bellmawr, New Jersey 08031

COM 2 - Heath/Zenith
Benton Harbor, Michigan 49022

COM 3 - Edmond Scientific
101 E. Gloucester Pike
Barrington, New Jersey 08007

COM 4 - Springboard Software, Inc.
7808 Creekridge Circle
Minneapolis, Minnesota 55435

COM 5 - Graymark International, Inc.
P.O. Box 17359
Irvine, California 92711

COM 6 - Baudville Publishing Co. (Available through most software dealers)

COM 7 - Omnitron Electronics
770 Amsterdam Avenue
New York, New York 10025
1-800-223-0826

COM 8 - Allied Electronics
401 E. 8th Street
Fort Worth, Texas 76102
1-312-697-8200

COM 9 - Hearlihy and Company
714 W. Columbia
P.O. Box 869
Springfield, Ohio 45501
1-800-622-1000

COM 10 - Chessell - Robo Company
Cord./111 Pheasant Run
Newton, Pennsylvania 18940
1-215-968-4422

COM 11 - Autocad
Auto Desk, Inc.
2320 Marinship Way
Sausalito, California 94965

Supplier List (continued)

COM 12 - Paxten Patterson
1001 W. Euless Boulevard
# 109
Euless, Texas 76040
1-800-262-1909

COM 13 - Kathy Bilz
1015 N. Sixth Street
Milwuakee, Wisconsin 53203
1-414-278-6743

TRANS 1 - Estes Industries
1295 H Street
Penrose, Colorado 81240

TRANS 2 - Creative Learning Systems, Inc.
2889 Hibert, Suite E
San Diego, California 92131
1-800-621-0852, ext. 804

MAN 1 - Radio Shack
(Local Store or Catalog)

MAN 2 - Toys "R" Us Toy Stores

MAN 3 - Creative Learning Systems, Inc.
2889 Hibert, Suite E
San Diego, California 92131
1-800-621-0852, ext. 804

MAN 4 - PITSCO
Box 1328
Pittsburg, Kansas 66762
1-800-835-0686